publications of the INSTITUTE of MARINE SCIENCE

Volume II
Number 2

DECEMBER
1952

Published by
Institute of Marine Science
The University of Texas
Port Aransas, Texas

Copies of this publication may be procured for $2.25 from the
Institute of Marine Science, Port Aransas, Texas

Publications of the Institute of Marine Science

Vol. II, No. 2

ERRATA

P. 26, for Electrophora read Elytrophora.

P. 30, change *Lernaeenicus longiventris* from Family Pseudocynidae to Family Lernaeidae.

P. 50, line 3 in key read "*Decapterus*" instead of "*Trachurus.*"

P. 53, line 27 read "part" instead of "parts."

P. 71, third paragraph, line 4 read "is" instead of "are."

P. 80, first paragraph of text, line 4 read "anal" instead of "caudal."

P. 94, second paragraph, line 2 read "on" instead of "an."

P. 107, legend to fig. a, line 1 read "538" instead of "534." This is the calculated length, the caudal being damaged; same specimen on page 106 recorded as 540 mm. in round numbers.

P. 125, second paragraph, line 2 read Atchafalaya for Atchafalya.

P. 133, sixth paragraph read Hymelia for Hymedia.

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Published by
The University of Texas
Printing Division
Austin

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Parasitic Crustacea from the Texas Coast

By

A. S. PEARSE

Duke University and Institute of Marine Science

[Reprinted from Publications of the Institute of Marine Science, December, 1952, Issue, Vol. II, No. 2]

From May 15 to July 16, 1951 the writer studied the parasitic crustaceans of fishes and crustaceans at Port Aransas, Texas. H. H. Hildebrand supplied many host fishes; Martin D. Burkenroad, Mrs. Mildred Sandoz, Dr. S. H. Hopkins, Will Kucera, Harold Loesch, and Allen Anderson also furnished hosts for study. The shrimp trawlers and sport fishermen were also very co-operative. Dr. Gordon Gunter, Acting Director of the Institute of Marine Science, did everything possible to further the work. At the United States National Museum Dr. Fenner Chace and Paul Illg helped in the identification of specimens and supplied rare literature, largely from C. B. Wilson's collection. Thanks are extended to all these persons, without the help of whom the work would not have been as successful.

The writer examined 803 fishes belonging to 138 species, three species of crabs and two of shrimps. From these he secured 57 species of copepods (19 new), 7 isopods (1 new), and 3 barnacles. An account of these follows.

Order Cirripedia

Suborder Operculata

Chelonibia patula (Ranzani)

Common on the bodies of the blue crab, *Callinectes sapidus* Rathbun, and the spider crab, *Libinia* sp.

Suborder Pediculata

Octolasmis mülleri (Coker)

Common on the gills and to some extent on the mouth parts of *Libinia dubia* Milne-Edwards, and *Callinectes sapidus* Rathbun.

Suborder Rhizocephala

Loxocephalus texanus Boschma

This sacculinid was quite local in distribution. None was found at Port Aransas but it was quite common in some of the estuaries a few miles to the eastward on the abdomens of the blue crab, *Callinectes sapidus* Rathbun.

Order Copepoda

Suborder Arguloida

Family Argulidae

Argulus sp.

Two immature specimens were found in the gill cavity of a big-eye, *Priacanthus arenatus* Cuvier & Valenciennes, that was taken in a trawl off Campeche.

Suborder Cyclopoida

Family Ergasilidae

Ergasilus lizae Krøyer

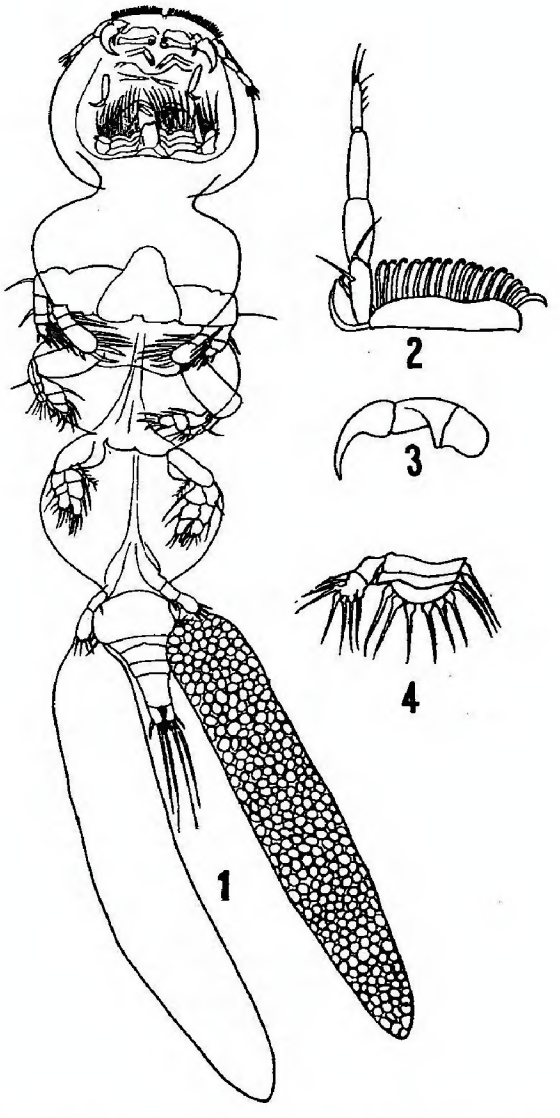
Over eighty specimens were collected from the gills of mullet, *Mugil cephalus* L.

Family Taeniacanthidae

Taeniacanthus lagocephali n. sp.

Figures 1–4

Female.—First thoracic segment fused with head into a cephalothorax that is wider than long (14:11); the anterior end rounded and the posterior end squarely truncated. Second thoracic segment somewhat shorter than third; third and fourth about equal. Cephalothorax a little wider than any succeeding segment. Genital segment short, nearly twice as wide as long. Abdomen tapering, first three segments wider than long, last segment longer than wide. Caudal rami 2-segmented, tipped with two long median setae and two short lateral setae. The egg cases are nearly as long as the body, and nearly two-fifths as wide. About 500 eggs in each case.



FIGURES 1–4, *Taeniacanthus lagocephali*

Female:—1, ventral view; 2, first antenna; 3, second antenna; 4, first leg.

First antennae 5-segmented; the basal segment armed throughout with stout, hooked, plumose setae. Second antennae 2-segmented, with a strong terminal curved hook. The maxillary hook is slender, slightly curved and chelate. The maxillae are a little longer and also chelate. The second maxillipeds are sturdy; basal segment is about two-thirds as wide as long; the terminal hook is less than half as long as that segment and rather blunt.

The swimming legs are biramous with 3-segmented rami, except the first pair in which the exopod is 2-segmented. The first legs have long setae which are turned forward so as to complete the setose circle on the ventral side of the cephalothorax. The second, third, and fourth legs are similar; all bear plumose setae; the second and third also have three spines on the endopod. The fifth leg is 2-segmented; it bears a seta on each side of the base and three or four on the tip of the terminal segment.

Length, 2.6 mm.; of cephalothorax, 0.6 mm., width, 0.8 mm.; length of egg sac, 2.3 mm.

Male, unknown.

Host.—Fourteen females were taken from the gills of four swellfish, *Lagocephalus laevigatus* (L.), collected in a trawl at a depth of eighteen fathoms off Padre Island. Type, U. S. Nat. Mus. No. 92682.

The specimens are like Sumpf's (1871) *T. cathariae* in the shape and size of the thoracic and abdominal segments but differ from that species in the character of the first and second antennae, the spines and setae on the legs. It differs from Wilson's (1911) *T. albidus* in the shape and character of the body segments, the character of the first and second antennae, the spinosity of the swimming legs, and the length and width of the egg sacs.

Telson, new genus

Female.—Head fused with first thoracic segment; cephalothorax wider than remainder of body; genital segment short; abdomen slender, longer than remainder of body. First antenna 4-segmented; second antenna 2-segmented, with a slender curved terminal hook. Maxilliped with a wide basal segment and a stout recurved terminal claw which bears a smaller lateral claw. Egg cases nearly as long as the abdomen and with about three eggs crosswide. Type, *Telson elongatus*, U. S. Nat. Mus. No. 92683.

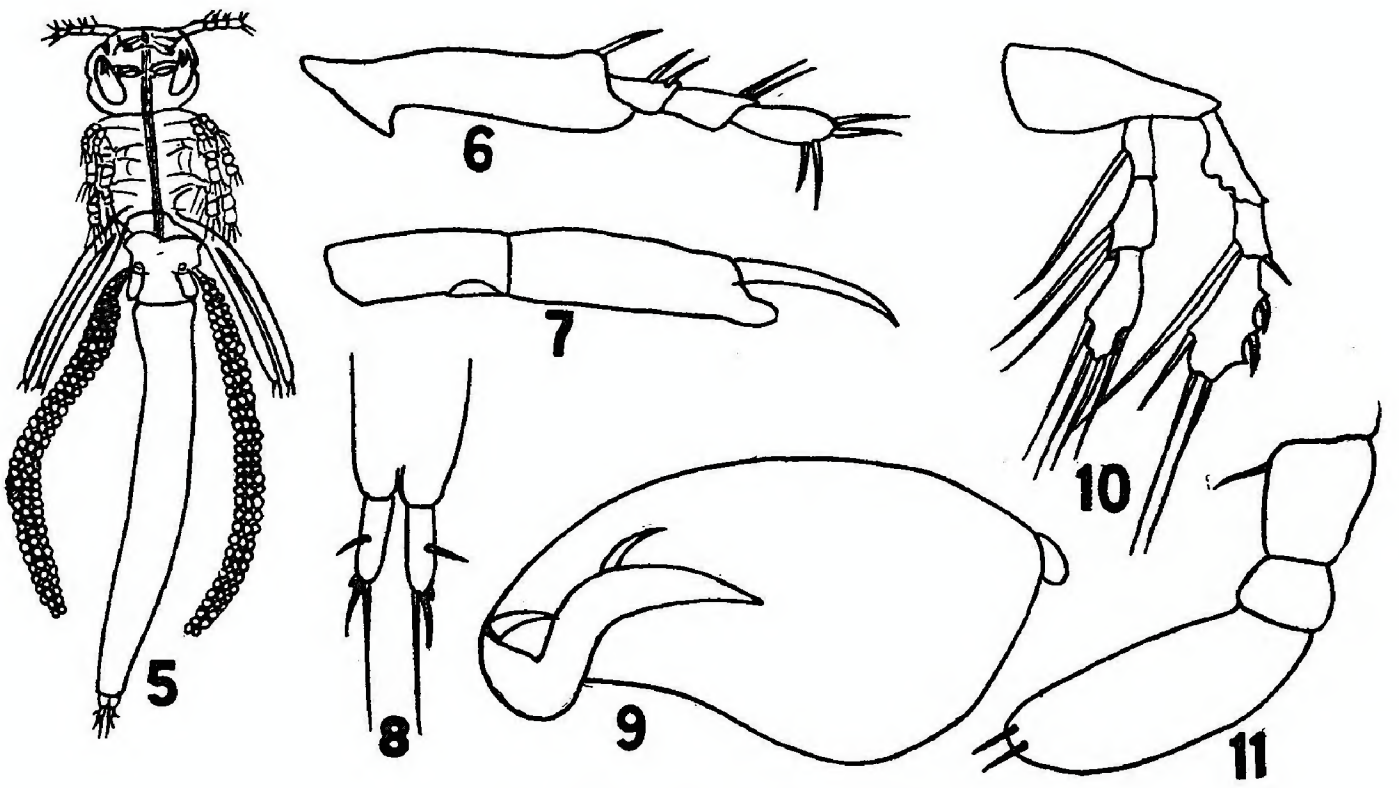
This genus differs from the genus *Anchistrotos* Brian 1906, in its long 1-segmented abdomen with no lamellar plates on the anterior end and the peculiar maxillipeds which have a wide basal segment and a stout terminal claw which bears a small lateral claw.

Telson elongatus n. sp.

Figures 5–11

Female.—Cephalothorax ellipsoidal, flattened, wider than long, with lateral indentations. Second thoracic segment almost as wide as cephalothorax; third and fourth decreasingly wide. Genital segment about as long as wide, with small ventral lamellar rounded plates. Abdomen, 1-segmented, with two pairs of small lamellar plates at the anterior end, long and cylindrical, tapered at posterior end. Caudal rami more than twice as long as wide, rounded at tip and armed with a small spine and a long and a short seta.

First antennae 4-segmented, the basal segment longest and the others in order of length 4, 3, 2. Second antenna 2-segmented, with a slender terminal hook. First maxilla is a small hook; second maxilla slender with two terminal setae. The second maxilliped is quite distinctive, with a swollen basal segment, a recurved terminal hook which bears a small lateral hooklet, and beside the large hook is another small hooklet; it lies along the side of the head.



FIGURES 5–11, *Telson elongatus*

Female:—5, ventral view; 6, first antenna; 7, second antenna; 8, caudal rami; 9, second maxilliped; 10, third leg; 11, fifth leg.

The first three pairs of legs are much alike; all are biramous with 3-segmented rami that bear spines and setae. Fourth leg, biramous, round, and unsegmented; fifth leg uniramous, flat, 3-segmented, and with two terminal setae.

Length of entire body, 3.8 mm.; length of cephalothorax and free thorax, 1.5 mm.; width of cephalothorax, 0.58 mm.; length, 0.39 mm.; length of abdomen, 2.3 mm.

Male unknown.

Host.—Four females were taken from inside the operculum one of two star-gazers, *Astroscopus y-graecum* (Cuvier & Valenciennes).

The distinctive features of this species are the long abdomen and the peculiar maxillipeds.

Grandiunguidae, new family

Suborder Cyclopoida. Members of this family resemble those in the Ergasilidae somewhat. They differ in that the second antennae and second maxillipeds are large and prominent; the first legs are uniramous and end in a hook; and the second, third, and fourth legs are all biramous with 2-segmented rami.

Grandiungus n. gen.

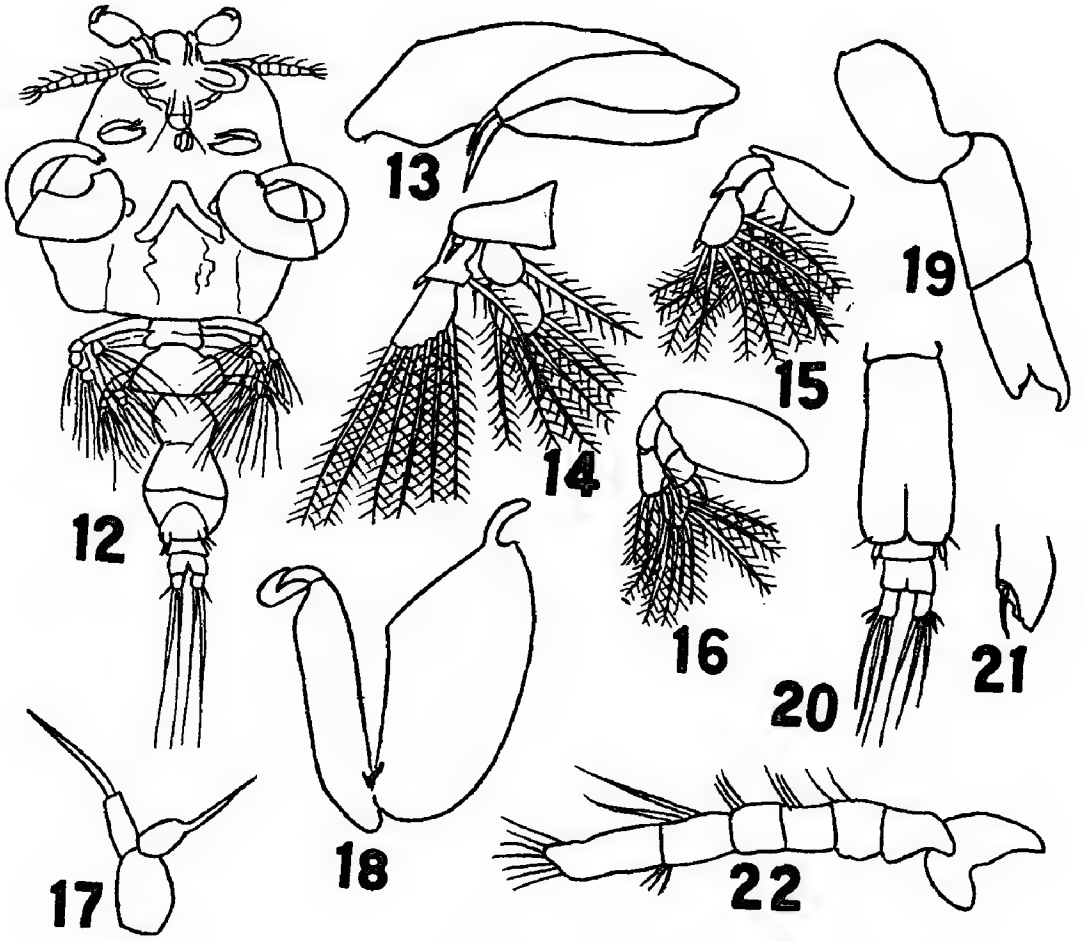
With the characters of the family. *G. promicrops*, type species.

Grandiungus promicrops n. sp.

Figures 12–22

Female.—Cephalothorax three-fourths as wide as long; with two large cavities at the anterior end for the reception of the second antennae; somewhat narrower in front and truncate; widest a little posterior to the middle; posterior margin straight, lateral angles rounded. First thoracic segment fused with thorax; next three free. Genital segment about two times as long as wide; sides straight. Abdomen 2-segmented; a third as long and about two-thirds as wide as genital segment; anterior segment a third as long as the second. Caudal rami rather rectilinear, slightly incurved, a third longer than wide; with two short lateral setae near the tip and two long terminal plumose setae.

First antennae 7-segmented; somewhat setose. Second antennae 2-segmented, with a short curved terminal hook; two basal segments, stout; they may be partially retracted into shallow cavities in the front of the head. Mouth tube, round. First maxilla with base a half longer than wide, with rounded margins, two rami two-thirds as long as base and each bearing a single long seta. First maxilliped with base rather stout, distal segment more slender and tipped with a short hook and a small lamella. Second maxilliped gigantic; basal segment, stout, with a seta near the base, terminal hook rough at the tip and with a small seta.



FIGURES 12–22, *Grandiungus promicrops*

Male:—12, ventral view; 13, first maxilliped; 14, second leg; 15, third leg; 16, fourth leg.
Female:—17, first maxilla; 18, first maxilliped; 19, first leg; 20, genital segment, abdomen, and caudal rami; 21, tip of second maxilliped; 22, first antenna.

First leg uniramous, 3-segmented, tipped with a curved hook and a process opposite it. Second, third, and fourth legs with two 2-segmented rami and with long setae. Fifth leg lamellar, with two small terminal setae. Egg sacs, unknown.

Total length of body, 3.75 mm., width, 1.7 mm.; cephalothorax length, 1.7 mm.; genital segment length, 1.2 mm.

Male.—Like female, but first maxilliped is more slender and ends in two long setae, the genital segment is enlarged toward the posterior end and is something like an hour glass in shape; the size is somewhat smaller.

Length of entire body, 3.1 mm., width, 1.5 mm.; cephalothorax length, 1.55 mm.

Host.—Seven females, two males, and two chalimi were taken from the gills of 5 spotted jewfishes, *Promicrops itiaria* (Lichenstein).

Types.—U. S. Nat. Mus. No. female, 92675; male, 92676.

Family Bomolochidae

Bomolochus attenuatus Wilson

Two specimens were taken from the gills of a big-eye, *Priacanthus arenatus* Cuvier & Valenciennes, and one from a sole, *Gymnachirus texae* (Gunter).

Bomolochus nothrus Wilson

A single specimen from one of 5 bat-fish, *Ogcocephalus vespertilio* (L.).

Bomolochus teres Wilson

Two from one of 56 striped mullet, *Mugil cephalus* L.

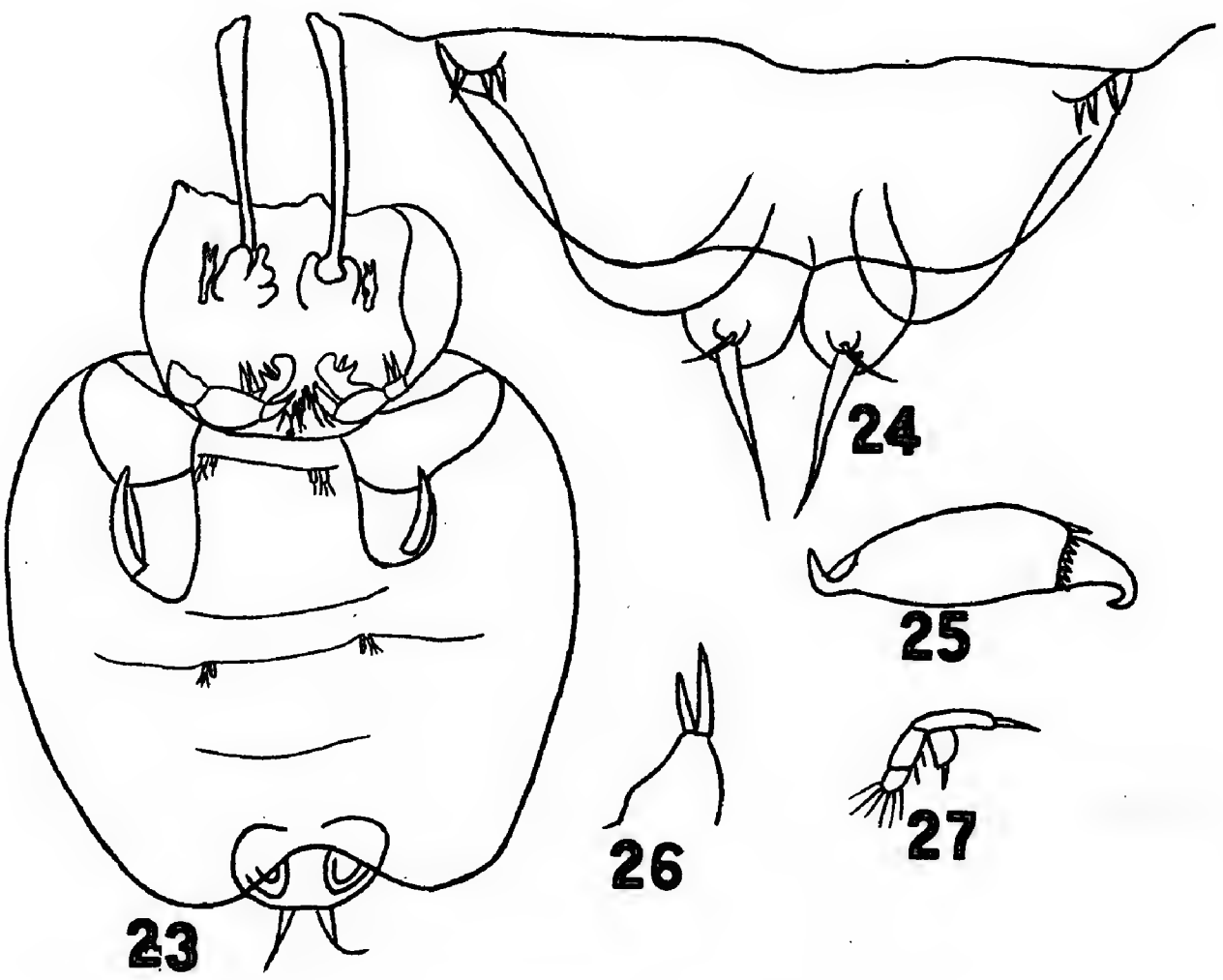
Tucca sp.

Figures 23–27

Females.—Anterior portion of head missing; two slender rods are embedded and extend forward on either side. Remaining portion of cephalothorax wider than long, truncate in front, rounded posteriorly. The fused thorax is somewhat longer than wide, ellipsoidal in form. The abdomen, visible in dorsal view; short and more than three times as wide as long; with 3 spines at the anterolateral corners which perhaps represent the fifth legs. Caudal rami, short, spherical, and tipped with a long and a short seta.

The mandibles are 3-segmented, rather stout, the terminal segment forming a slightly curved hook. The first maxillae are armed with three long setae. The second maxillae have a stout base and two terminal segments. The first maxilliped is rather slender, with a row of spinules around the base of the terminal hook. The second maxilliped is situated far back, has a sowewhat triangular basal segment, an elongate second segment, and a slightly curved terminal hook. The third and fourth legs are biramous; exopods 2-segmented and setose; endopods 1-segmented and ending in a single seta.

Length of body without two anterior processes, 1.4 mm., width, 0.8 mm.; cephalothorax, length, 0.3 mm., width, 0.5 mm.; fused thorax, length, 0.9 mm., width, 0.9. mm.; abdomen, length, 0.2 mm., width, 0.4 mm.



FIGURES 23–27, *Tucca* sp.

Female:—23, ventral view; 24, fifth legs, abdomen, and caudal rami; 25, second maxilliped; 26, first maxilla; 27, second leg.

Male unknown.

Hosts.—A single specimen was taken from one of 4 smooth swellfish, *Lagocephalus laevigatus (L.)* and one of 2 crimson sea robins, *Prionotus ophryas* Jordan & Swain.

As the anterior ends are missing and some of the structural details are not clear these specimens are tentatively assigned to the genus *Tucca*.

Tuccopsis n. gen.

Female.—These copepods resemble Krøyer's genus *Tucca* (1837) in their general configuration but differ in possessing large, bluntly rounded, minutely biramous second legs on the anterior end of the fused thoracic segments. Body with three regions, a small cephalothorax joined by a short neck to a fused and rotund trunk, and a minute genital segment and abdomen. The latter are folded forward under the thorax, which is about as wide as long. Cephalothorax with lamellar lateral extensions. Maxillipeds have a terminal hook with a lamellar extension on its inner margin and a blunt process on its basal segment. Egg sacs a little longer than body; eggs in several rows.

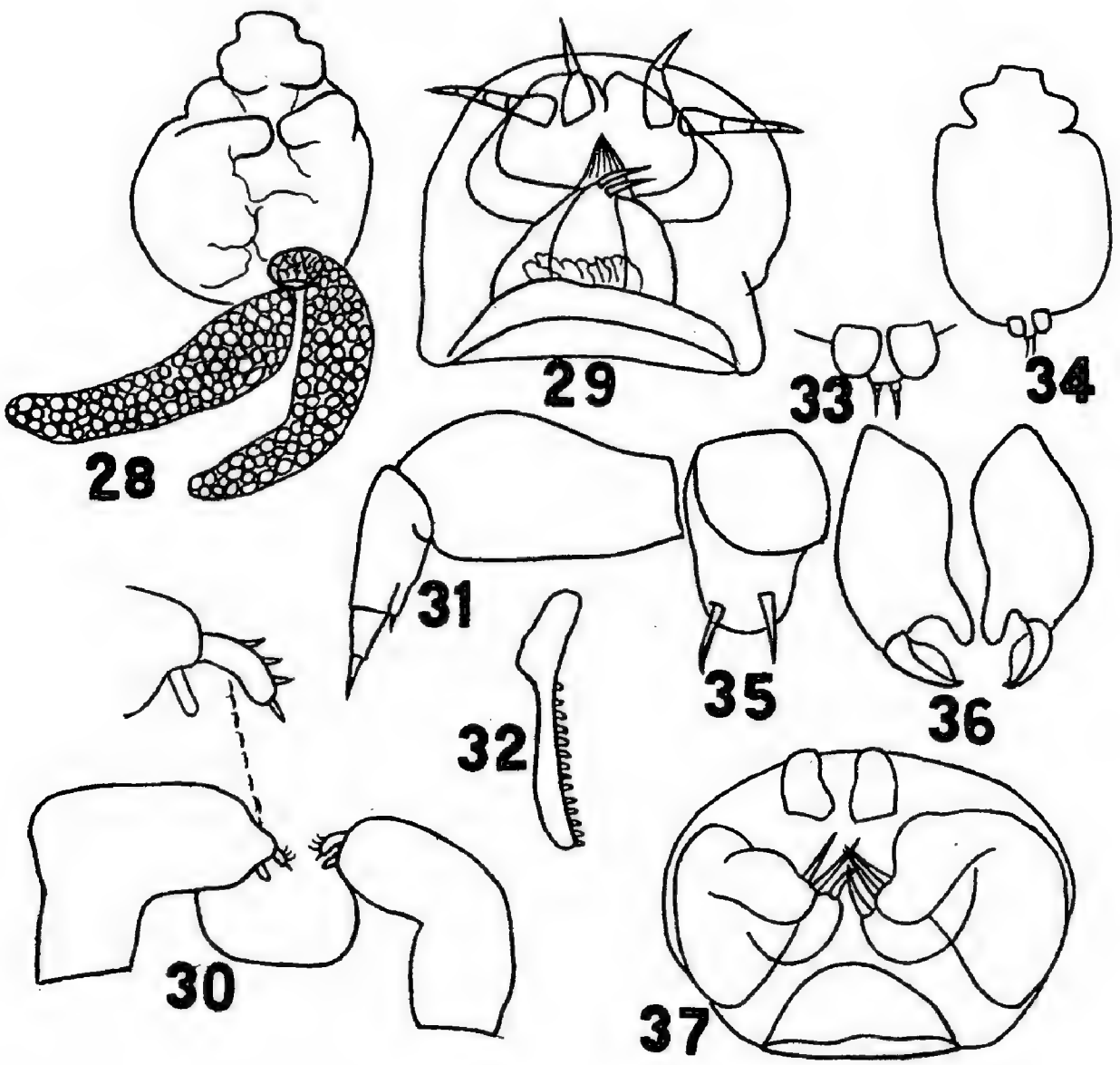
Male.—Similar to female but the thorax is narrower; abdomen and caudal rami are not folded under but protrude a little from the posterior end.

Type.—*Tuccopsis pinguis* Pearse.

Tuccopsis pinguis n. sp.

Figures 28–37

Female.—With characters as given under diagnosis of the genus. No first antenna can be observed in any of the seven specimens available. Females are evidently mature as they bear long egg sacs but none show swimming legs. What appear to be the second legs are large, blunt angulated clasping organs which bear two small 1-segmented rami; exopod with four spines. Second antenna 3-segmented, with a terminal seta and lateral seta at the tip of the second segment. Mandible rather stout, with about fourteen teeth. Maxilliped with a lamellar wing on the inside of the terminal claw and a slender process rounded at the tip on the basal segment opposite the claw. Abdomen and caudal rami turned under thorax; it appears to bear biramous, setose rudiments of the fifth legs and pair of unarmed caudal rami.



FIGURES 28–37, *Tuccopsis pinguis*

Female:—28, ventral view; 29, ventral view of head; 30, second leg; 31, second antenna; 32, mandible. Male:—33, posterior end; 34, dorsal view; 35, caudal ramus; 36, second maxillipeds; 37, female, abdomen and caudal rami.

Length of entire body, 1.7 mm., width, 1.3 mm.; cephalothorax, 0.4 mm., width, 0.6 mm.; fused thorax, length, 1.3 mm.; abdomen, length, 0.25 mm.

Male.—Similar to female. Body more slender and abdomen not turned under thorax. Abdomen with two terminal setae. Caudal rami not quite as long as abdomen.

Length of entire body, 1.5 mm., width, 1.0 mm.; cephalothorax, length, 0.3 mm.; width, 0.7 mm.

Hosts.—Four females and a male were taken from the gills of two sea robins, *Prionotus pectoralis* Nichols & Breder and two from 6 *Prionotus martis* Ginsburg. Types, U. S. Nat. Mus., female, 92684; male, 92685.

Suborder Caligoida

Family Caligidae

Caligus coryphaenae (Steenstrup & Lütken)

A single female from the body of a dolphin, *Coryphaena hippurus* L.

Caligus haemuronis Krøyer

Quite common; the following numbers taken from the fishes indicated: *Pogonias cromis* (L.), 1 from 13; *Bagre marina* (Mitchill), 3 from 11; *Galeichthys felis* (L.), 17; *Archosargus probatocephalus* (Walbaum), 1 from 17; *Chaetodipterus faber* Broussonet, 1 from 13; and *Sciaenops ocellatus* (L.), 2 from 6.

Caligus praetextus Bere

One from the catfish, *Galeichthys felis* (L.) and 31 from the gills of a single gray snapper, *Lutianus griseus* (L.).

Caligus productus Dana

From four fishes, the numbers indicated:—*Scomberomorus cavalla* (Cuvier & Valenciennes), 3 from 18; *Sarda sarda*, 2 from 8; *Elops saurus* L., 1 from 19; and *Coryphaena hippurus* L., 46 from 13.

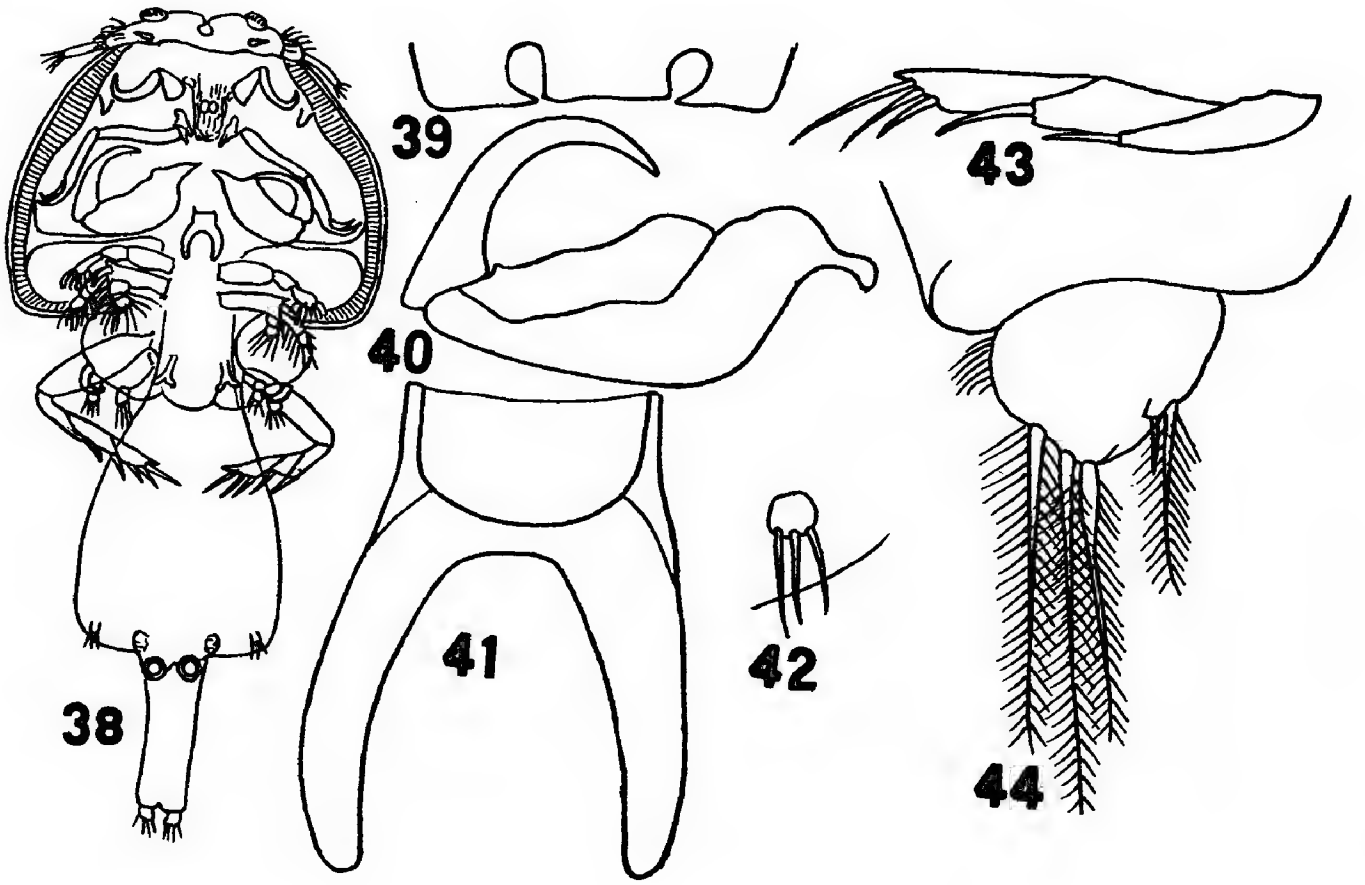
Caligus rectus n. sp.

Figures 38–44

Female.—Cephalothorax about a third of the entire length; posterior margin straight (hence specific name), the outer lobe produced into a sharp spine-like process at its inner angle and this almost meets the median portion of the carapace. Cephalothorax much wider than long; rounded in front. Frontal plates rather narrow; lunules small. Free thoracic segment wider than the third, narrow in front. Genital segment slightly more than half as wide as chephalothorax; ovate. Abdomen slender, nearly half as long as the genital segment. Caudal rami small, about a tenth the length of the abdomen. Egg strings about three-fourths as long as the body; contain about 105 eggs.

Frontal plate with shallow but prominent lunule. Second antenna with sharply curved terminal hook that is longer than the basal segment. First and second maxillae of the usual types. First maxilliped slender, the terminal segment longest, two claws strongly

curved. Second maxilliped with rather slender basal segment and sharply curved terminal spine. Furca with truncate anterior portion rather short; posterior rami stout, blunt, and slightly incurved.



FIGURES 38–44, *Caligus rectus*

Female:—38, ventral view; 39, posterior margin of cephalothorax; 40, second maxilliped; 41, furca; 42, fifth leg; 43, tip of fourth leg; 44, right caudal ramus.

First leg uniramous, 3-segmented, terminal segment with four plumose ventral setae and three terminal spines which are recurved at their tips. Second leg biramous; exopod 3-segmented and armed with three strong lateral hooks and plumose terminal setae; endopod 3-segmented and setose. Third leg with a flat discoidal basal segment, a small 2-segmented setose exopod, a strong curved hook, and a 1-segmented setose endopod. Fourth leg uniramous, 4-segmented, with slender spines and a minute terminal spine. Fifth leg near the posterolateral margin of the genital segment, spheroidal, with three setae.

Length of entire body, 4.9 mm.; length of cephalothorax, 1.8 mm., width, 2.26 mm.; length of genital segment, 1.9 mm., width, 1.2 mm.; length of abdomen, 0.85 mm., width, 0.3 mm.

Male.—Unknown.

Host.—Eleven specimens were taken from the gills of seven jacks, *Caranx hippos* (L.). Type, U. S. Nat. Mus. No. 92665.

This species is characterized by the wide cephalothorax with spiny ending that almost closes the posterior sinuses and its straight posterior margin; also by its peculiar furca, long genital segment and abdomen.

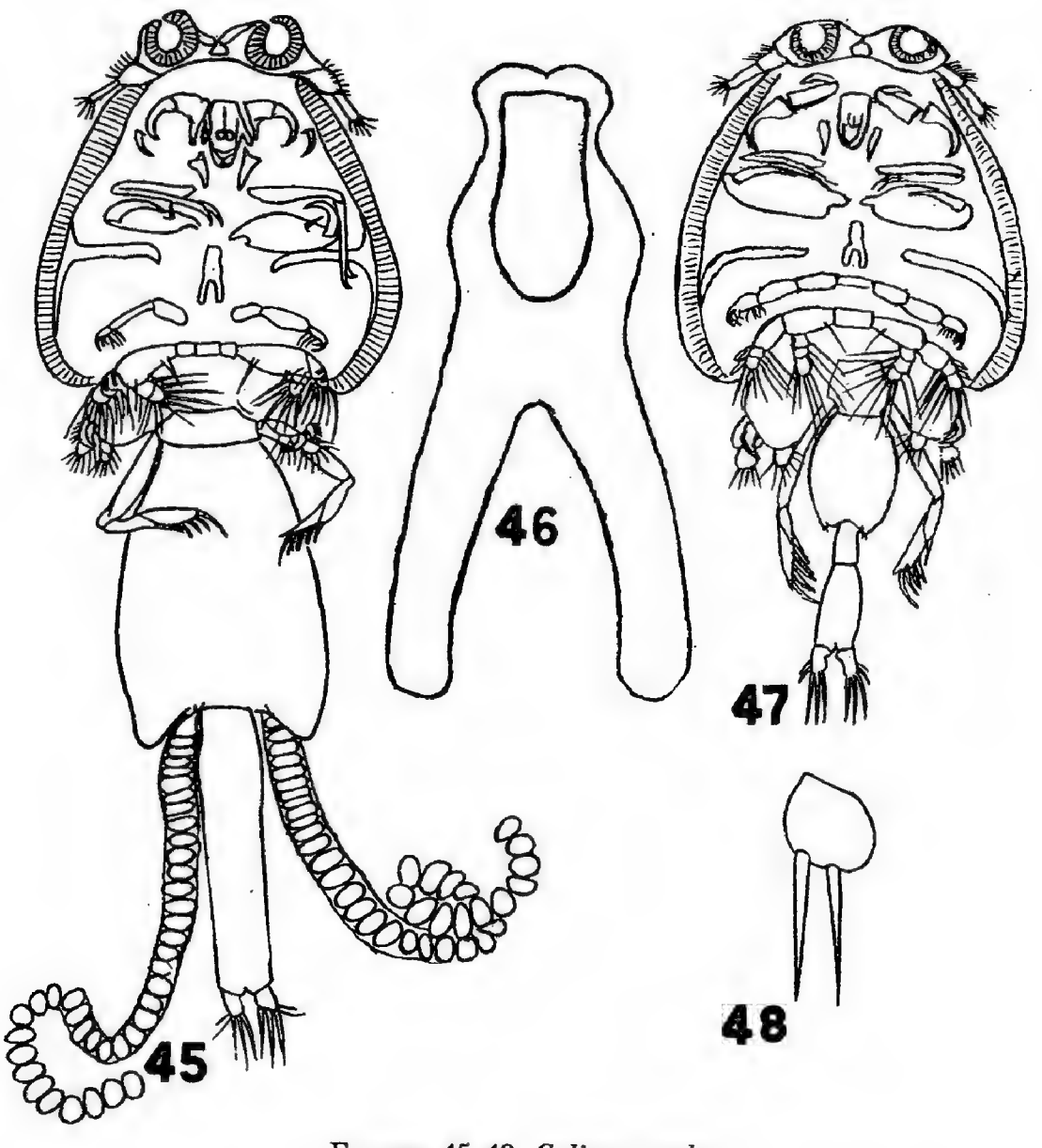
Caligus sarda n. sp.

Figures 45–48

Female.—Body form rather slender. Cephalothorax about as wide as long; rounded at corners; posterior sinuses shallow; narrower in front. Frontal plates wide, with a deep median sinus; lunules large and prominent, lateral thickenings T-shaped with the anterior branch short. Free segment short, less than a third as wide as the cephalothorax. Genital segment ovate, with wide lobes at the posterior corners; nearly as long as the cephalothorax. Abdomen a little longer than the genital segment, slender, 1-segmented. Caudal laminae a little longer than wide, with one short and three long plumose terminal setae. Egg strings about three-fourths as long as body; with 43–48 eggs, which are rounder and evidently being shed at the posterior end.

Second antennae with a spinous process on the basal segment. Eyes small and close together in the middle of the mouth tube. Second maxillipeds slender, with a seta near the distal end of the base. Furca with a slender base and wide posterior arms that are bluntly rounded at their tips. Legs of the usual pattern but the fourth legs 3-segmented.

Total length, 6.35 mm.; cephalothorax, length, 2.2 mm., width, 2.3 mm.; genital segment, length, 1.9 mm., width, 1.3 mm.; abdomen length, 1.85 mm. Type, U. S. Nat. Mus. No. 92667.



FIGURES 45–48, *Caligus sarda*

Female:—45, ventral view; 46, furca. Male:—47, ventral view; 48, fifth leg.

Male.—Body shorter and cephalothorax wider than that of female. First maxilla longer and sharper than female's; basal segment of second maxilliped much wider; genital segment ellipsoidal; fifth leg nearly spherical with two terminal setae; abdomen 2-segmented, the second segment longer and wider than the first.

Total length, 4.1 mm.; cephalothorax, length, 2.1 mm., width, 2.25 mm.; genital segment, length, 0.7 mm., width, 0.58 mm.; abdomen, length, 0.85 mm., width, 0.36 mm. Type, U. S. Nat. Mus. No. 92667.

Host.—Five females and a male were taken from the roofs of the mouths of three common bonitos, *Sarda sarda* (Bloch).

This species is distinguished by the peculiar furca, short abdomens of male and female, rotund male fifth legs, and the small second antennae.

Caligus sciaenops n. sp.

Figures 49–59

Female.—Cephalothorax slightly more than one-third the body length, almost as wide as long. Frontal plates wide and prominent; lunules large, circular, and projecting. Lateral lobes rounded, with a small lobe at the median angle. Lateral thickening at the level of furca not T- or Y-shaped but prolonged backward and not extended forward. Free thoracic segment short and narrow, two-thirds as wide as genital segment. Genital segment rectangular, with straight sides and rounded corners, narrowed in front. The abdomen in the specimen from *Cynoscion nebulosus* is more ovoid. Abdomen almost as long as the genital segment, 2-segmented, the terminal segment one-sixth as long as the basal segment. Caudal rami short, triangular, with five plumose setae. Egg strings almost two-thirds as long as body; with about thirty-one eggs.

First antennae short and robust; 2-segmented; basal segment with three papillae and about nine strong setae; five terminal setae. Second antenna with a sharp, curved hook. First maxilla a strongly curved sharp hook with a swollen base. Second maxilla small, bifid at tip. First and second maxillipeds very slender; first with the usual two terminal curved setae, second with a seta on the distal third of the terminal hook. Furca with an ovate body and two slightly curved tapering branches. First leg, uniramous, slender, with last segment armed with three claws of decreasing length and a single seta. Second leg biramous; rami 3-segmented, segments rather short. Third leg flat, rounded, with the usual posterior hook and 2- and 1-segmented rami. Fourth leg, uniramous, 4-segmented; of the terminal spines the basal one is longer than the second and the terminal spine longer than the third and fourth. Fifth legs not observed.

Length of entire body, 3.1 mm.; of cephalothorax, 1.3 mm., width, 1.27 mm.; genital segment, length, 0.8 mm., width, 0.65 mm.; abdomen, length, 0.7 mm., width, 0.15 mm.; length of eggstring, 2.0 mm.

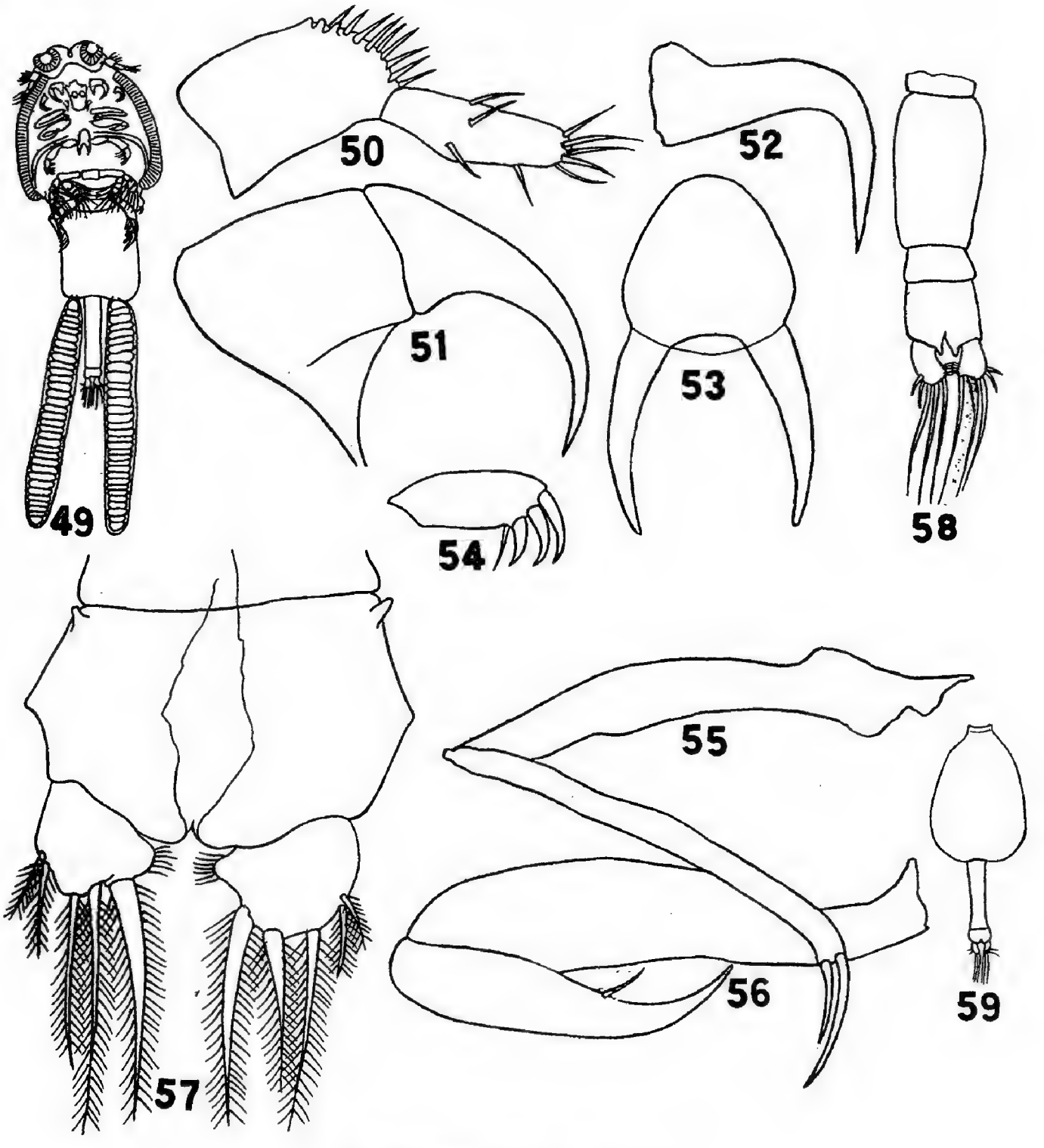
Male.—Similar to female, but the abdomen shorter and the first segment about half the length of the second.

Hosts.—Two females were taken from the gills of one of six channel bass, *Sciaenops ocellatus* (L.). A male and female were also found on the roof of the mouth of a

Cynoscion nebulosus (Cuvier & Valenciennes) and a single male on the gill of one of eleven *Cynoscion nothus* (Holbrook).

Types.—U. S. Nat. Mus. Female, 92668; male, 92669.

This species is somewhat like Bere's (1936) *C. praetextus* which she described from a related species of fish but differs in its furca, the lateral, chitinous thickening opposite the furca which is not T- or Y-shaped but bends backward, the shape of the abdomen, the setae on the first leg, and the caudal rami. It differs from Wilson's (1905) *C. mutabilis*, which probably came from the same host as the present species and from his (1913) *C. tenax* in the same features.



FIGURES 49–59, *Caligus sciaenops*

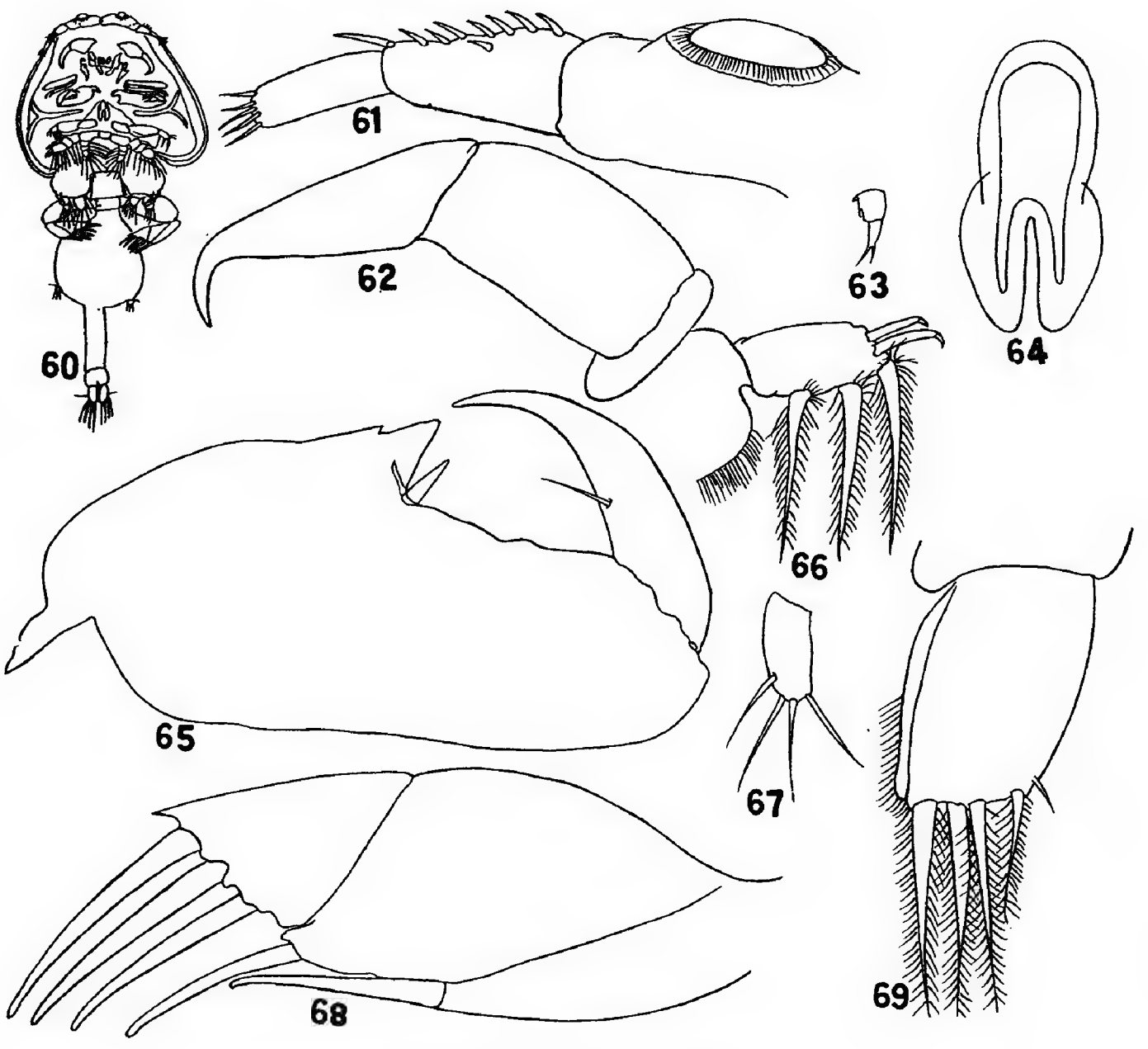
Female:—49, ventral view; 50, first antenna; 51, second antenna; 52, first maxilla; 53, furca; 54, terminal segment of first leg; 55, first maxilliped; 56, second maxilliped; 57, last segment of abdomen and caudal rami; 58, 59, genital segment, abdomen, and caudal rami from *Cynoscion nebulosus*, 58, male, 59, female.

Caligus validus n. sp.

Figures 60–69

Female.—Cephalothorax one-sixth wider than long, narrower in front. Frontal plates not very wide, emarginate in middle. Lunules not very deep. Lateral lobes rounded and shallow; posterior sinuses shallow. Thoracic area less than half the length of the cephalothorax. Eyes rather small, and well forward. Free thoracic segment wider than long, narrower anteriorly, about a third the width of the genital segment. Genital segment more than half as wide as cephalothorax, wide and pear-shaped. Abdomen 2-segmented, anterior segment four times as long as the posterior. Anal rami longer than wide, with four plumose terminal setae and a small lateral seta.

First antenna with a wide, triangular basal segment which bears a small setose appendage on its posterior corner, terminal segment a little shorter than basal. Second antenna with terminal hook sharply bent at tip and a little longer than preceding segment. First maxilla very small; second maxilla stouter. Mouth tube wide and short. Mandible with twelve teeth. First maxilliped rather wide, with two terminal claws.



FIGURES 60–69, *Caligus validus*

Female:—60, ventral view; 61, first antenna; 62, second antenna; 63, second maxilla; 64, furca; 65, second maxilliped; 66, tip of first leg; 67, fifth leg; 68, tip of fourth leg; 69, caudal ramus.

Second maxilliped with a wide basal segment that has a triangular process and a short wide seta opposite the terminal hook, which carries a seta on its inner margin at the end of its basal third. The lateral thickenings behind the maxillipeds are Y-shaped instead of the usual T-shape. The furca is rounded in front with two very wide, blunt posterior branches.

The swimming legs are all very wide. The first leg is uniramous, 3-segmented and ends in two small down-bent spines; terminal segment also bears three plumose setae. Second leg biramous and each ramous is 3-segmented. Third leg with a flat, hooked basal segment; exopod 2-segmented and endopod 1-segmented. Fourth leg very wide, with the usual five spines. Fifth leg longer than wide, with a lateral and three terminal setae.

Total length of body, 3.7 mm.; cephalothorax, length, 1.5 mm., width, 1.85 mm.; genital segment, length, 0.95 mm., width, 0.88 mm.; abdomen, length, 0.8 mm., width, 0.28 mm.

Host.—A single female was taken from the gill of *Caranx chrysos* (Mitchill). Type, U. S. Nat. Mus. No. 92671.

Male.—Unknown.

This species is distinguished from all others of the genus by its wide swimming legs, its Y-shaped lateral thickenings, the conformation of the second maxillipeds, the shape of the genital segment and abdomen.

Caligus ventrosetosus n. sp.

Figures 70–75

Female.—Body slender; carapace less than half the body length, one-fourth longer than wide, with small spines at posterior angles. Frontal plates thick and lunules very large. Eyes, large, red, and contiguous. A row of ten setae extend across the ventral surface immediately in front of the furca; for this feature the specific name is given. Genital segment, a third of the entire length, ovate in outline, truncated posteriorly, corners rounded; no fifth legs visible; three-fourths as wide as cephalothorax and two-thirds as long. Abdomen almost a third as long as the genital segment; narrower posteriorly; a little longer than wide. Caudal rami less than half as long as abdomen, three times as long as wide; with one short lateral, and a short and three long terminal setae. Egg strings unknown.

First antenna short, wide, and setose. Second antenna with a long spine on the basal segment, terminal hook slender and curved.

Mouth tube short. First maxilla longer than mouth tube. First maxilliped slender, with a long and a short terminal seta. Second maxilliped rather slender; terminal hook with a median swelling and a basal seta. Furca wide and stout; the base wider than long with divergent rami; the posterior rami wide, bluntly rounded, and slightly convergent.

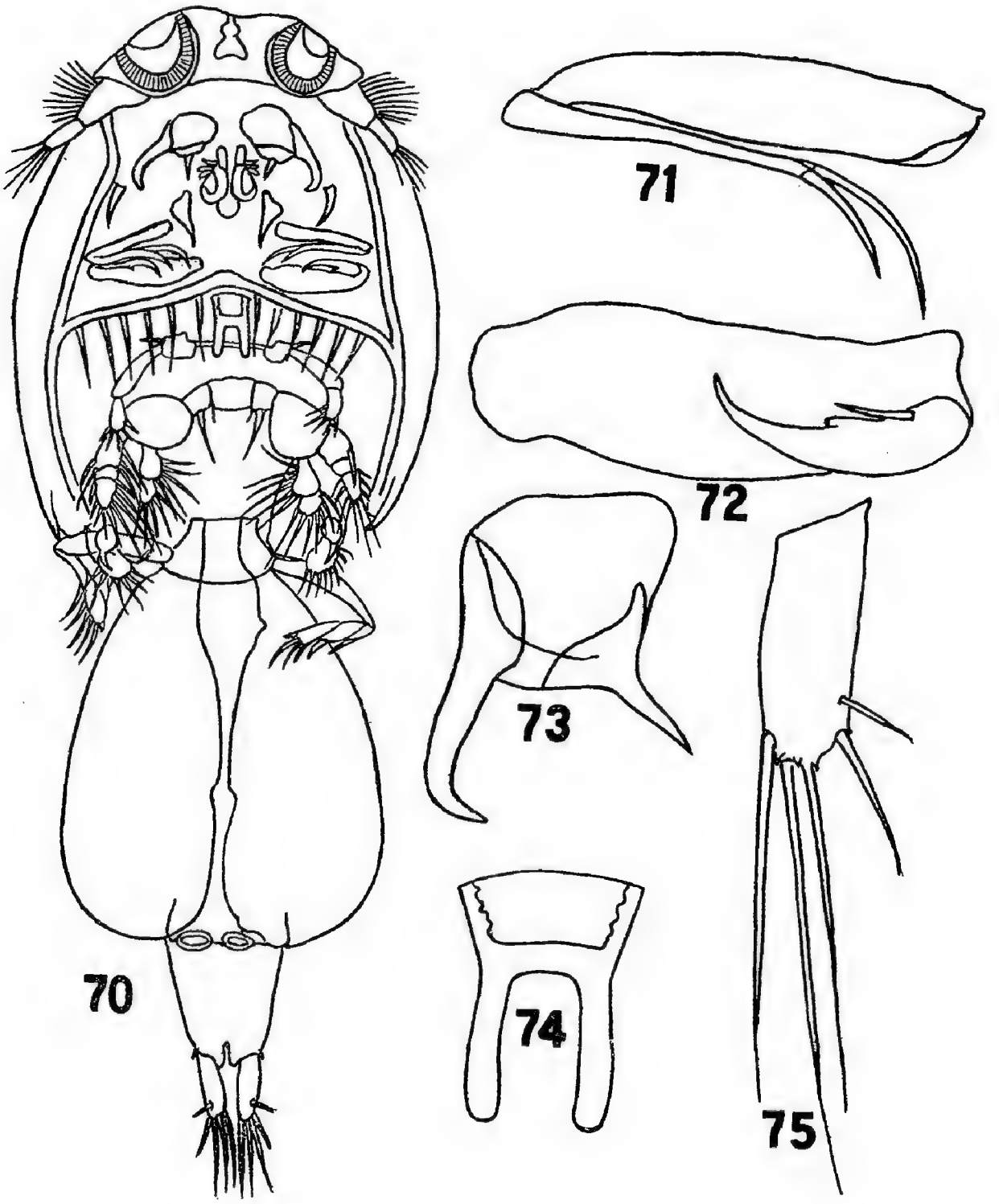
First and fourth legs, uniramous, the latter rather stocky. Second leg with rami 2- and 3-segmented; third leg with a rather narrow basal segment, a strong blunt lateral hook, and flat 1- and 2-segmented rami.

Length of body, 2.4 mm.; cephalothorax, length, 1.0 mm., width, 0.75 mm.; genital segment, length, 0.85 mm., width, 0.65 mm.

Males.—Unknown.

Host.—A single female was taken from the gill of one of, eight *Brevoortia gunteri* Hildebrand. Type.—U. S. Nat. Mus. No. 92670.

This species has a general form similar to Wilson 1913 *C. suffucus*, but is unique in possessing a row of setae across the cephalothorax, and differs in the length and shape of the abdomen, the armature of the fourth legs, and the character of the furca. The abdomen and caudal rami resemble those of *C. rufus* Wilson (1908) but the body is more slender and the row of ventral setae differ.



FIGURES 70–75, *Caligus ventrosetosus*

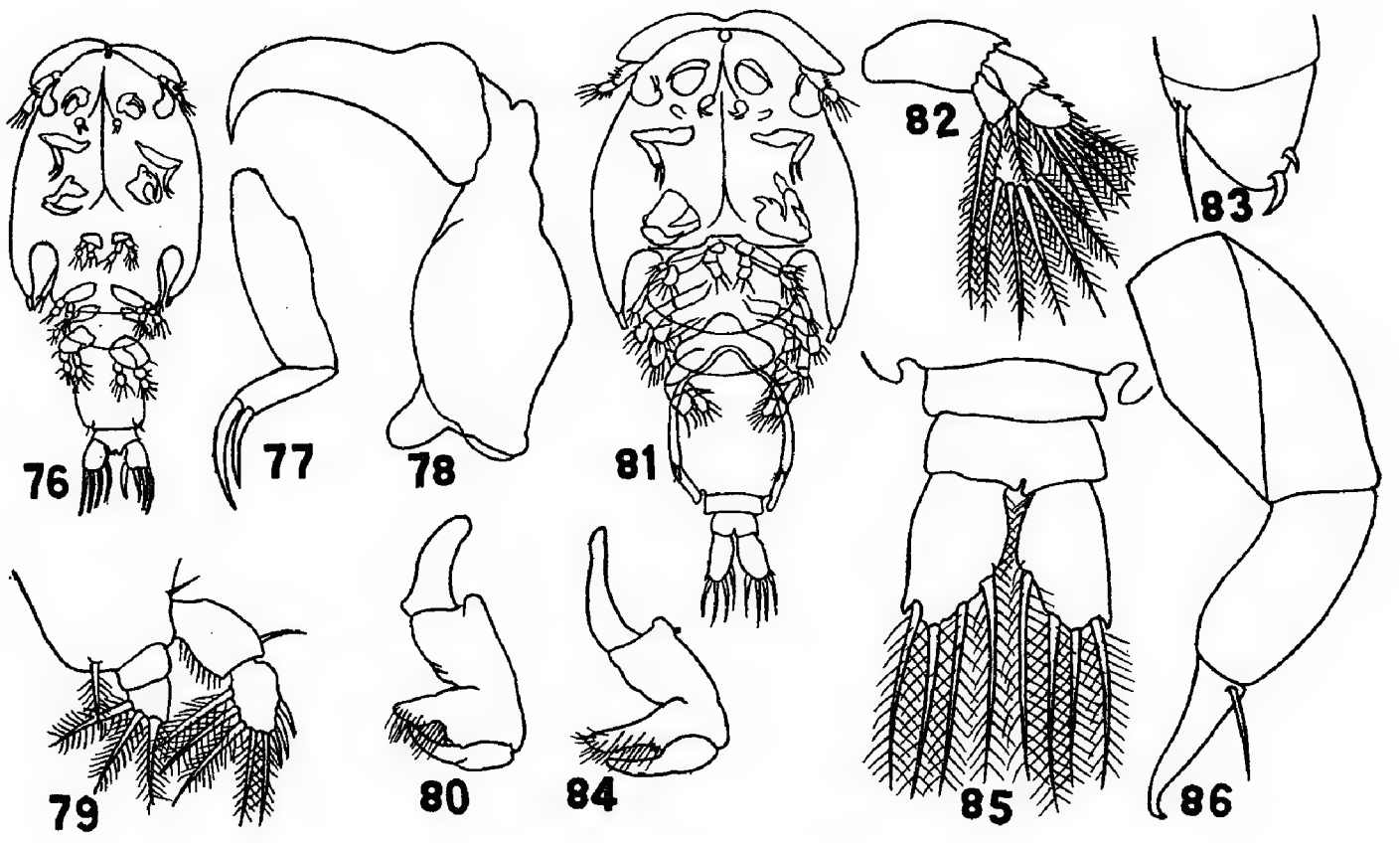
Female:—70, ventral view; 71, first maxilliped; 72, second maxilliped; 73, second antenna; 74, furca; 75, caudal ramus.

Dysgamus limbatus n. sp.

Figures 76–86

Female.—Cephalothorax more than half the entire length, truncate posteriorly; lateral lobes elongate, tapering, and rather acute; each bears a projection of the lateral thickening. The lateral lobes on the second thoracic segment reach a little beyond the third segment; second segment truncate and about as long as the third which is rounded posteriorly; fourth segment twice as wide as long, a third longer than the second. Genital segment not as wide as fourth and twice as long. Abdomen 1-segmented, wider than long. Caudal rami longer than abdomen, with four terminal plumose setae.

Frontal plates, wide, without lunules, with a deep depression at median line. Antennae 3-segmented, the basal segment very short, the middle segment longest and setose distally, the terminal segment setose. Second antenna with a wide basal segment, a more slender second segment and a curved terminal hook; a thickened ring is at the base. Maxillary hook is ellipsoidal; second maxilla small, with two stout terminal appendages. First maxilliped slender, with long and short terminal setae. Second maxilliped stout with a setose protuberance opposite the terminal claw. Mouth tube is slender and acuminate.



FIGURES 76–86, *Dysgamus limbatus*

Female:—76, ventral view; 77, first maxilliped; 78, second antenna; 79, first leg; 80, second maxilliped. Male:—81, ventral view; 82, fourth leg; 83, fifth leg; 84, second maxilliped; 85, abdomen and caudal rami; 86, second antenna.

All swimming legs biramous and the rami 2-segmented; first pair much smaller than the other three; all have spines on the lateral margin of the exopod and both rami bear stout plumose setae. Fifth legs are represented by a small conical lobe with a terminal seta on either side of the genital segment at the posterior corner. No furca can be observed.

Length of body, 3.2 mm., width of cephalothorax, 1.5 mm.; length of cephalothorax, 1.9 mm.; length of genital segment, 0.6 mm.

Male.—Like the female except that the abdomen is 2-segmented, the genital segment has the fifth legs farther forward and they bear a curved and a nearly straight spine as well as a seta.

Length, 4.1 mm.; width, 2.0 mm.; length of cephalothorax, 2.3 mm.

Host.—A male and what appear to be four immature females were taken from the skin of one of four sharks, *Carcharinus limbatus* (Müller & Henle). Type, female and male U. S. Nat. Mus. No. 92672.

These specimens differ from others described in the genus *Dysgamus* in the character of the ellipsoidal maxillary hooks, the small fifth legs, setose protuberance on the second maxillipeds, and in the absence of a furca.

Lepeophtheirus christianensis Wilson

From the sea catfish, *Galeichthys felis* (Cuvier & Valenciennes), 8 specimens from 69.

Lepeophtheirus monacanthus Heller

From the gaff-topsail catfish, *Bagre marina* (Mitchill), 9 individuals from 11 fish; more often on the roof of the mouth, rather than the gills.

Echetus typicus Krøyer

Eighteen from 6 channel bass, *Sciaenops ocellatus* (L.).

Tuxophorus caligoides Wilson

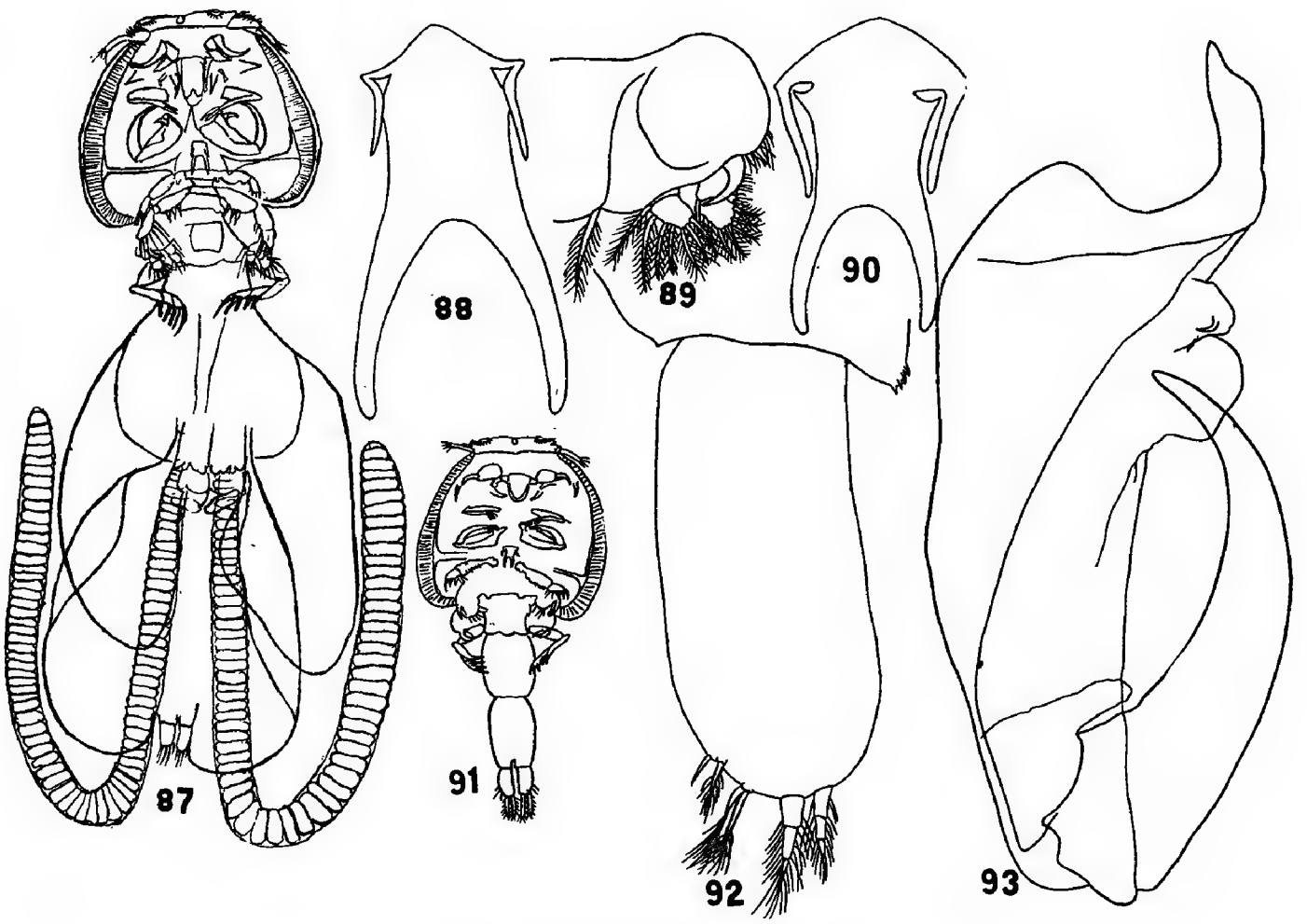
Six from one of 5 spotted jewfish, *Promicrops itiaria* (Lichenstein); mostly on the head, but one in mouth.

Parapetalus gunteri n. sp.

Figures 87–93

Female.—Carapace one-fourth the entire length, nearly one-fourth wider than long, and somewhat truncate posteriorly. Frontal plates wide, with a depression and a circular cavity at the center of the anterior margin. Lunules shallow and projecting very little. Eyes small and contiguous. Posterior sinuses broad and shallow, the median lobe about one-third the entire width and not projecting behind the lateral lobes. Fourth segment about one-third as wide as carapace and narrowed anteriorly. Genital segment orbicular and slightly longer than wide. It is three-quarters as wide as the carapace. It is produced on its ventral surface into two membranous wings which project laterally to exceed the width of the carapace. The abdomen is one and a half times as long as the genital segment. It bears two lateral wings which extend posteriorly a little beyond the anal laminae. The caudal laminae bear four setae which are about equal in length. The egg strings may be longer than the entire body and bear 60 to 100 eggs.

The second antennae have a stout basal segment with a long, slender terminal hook. Mouth tube nearly twice as long as wide, tapered somewhat, rounded at tip, and similar to Wilson's (1905) description of that of *P. occidentalis,* except that there is no "fringe of long hairs." The first maxillae lie just posterior to the tips of the second antennae. They have a wide base and a rather acute tip. The second maxillae are on either side of the mouth tube. They are slender and acute. Anteriad to them are a pair of papillae. Each bears two setae, the outer one three times as long as the inner one and jointed near its base. The first maxillipeds are slender and bear two terminal setae. The second maxillipeds are also slender, with a short curved spine on the proximal end of the basal segment and a slender curved terminal claw. The furca has two slender curved posterior branches and two lateral branches that curve back on either side from the anterior region so as to leave a triangular opening on either side.



FIGURES 87–93, *Parapetalus gunteri*

Female:—87, ventral view; 88, furca; 89, third leg. Male:—90, furca; 91, ventral view; 92, left caudal ramus; 93, second maxilliped.

The first legs have a very short tubercle on the basal segment, three terminal spines and three short plumose setae. The second, third, and fourth legs are similar to those of *P. occidentalis,* but the fourth leg is somewhat more slender.

Total length, 8.2 mm.; length of carapace, 1.6 mm.; width of carapace, 1.9 mm.; length of egg strings, 6–13 mm.

Male.—Similar to female, but much smaller and without membranous wings. Frontal plates with lunules somewhat deeper than those of female. Carapace nearly a fifth wider than long. Maxillae slender. Spine on basal segment of second maxilliped, small. Furca

shorter on anterior end. Genital segment, ellipsoidal. Abdomen, 1-segmented, tapered slightly toward posterior. Anal rami longer than wide, rounded at tip and there bearing two 3-segmented plumose appendages, three plumose setae, and a seta. Total length, 4.2 mm.; width of carapace, 1.9 mm.

Eleven specimens were taken from the gills of eight *Rachycentron canadus* L.

Types.—Female and male, U. S. Nat. Mus. No. 92677.

The writer had some hesitation in designating this species as different from Wilson's (1905) *P. occidentalis* as it occurred on the gills and in the branchial cavity of the same host (*Rachycentron canadus* L.) but it appears to differ in several features: the lack of a notch on the sides of the carapace, the larger size, the greater length of the egg strings, the presence of a stout spine at the base of the second maxillipeds, the shape of the furca, and the peculiar appendages on the caudal laminae of the male. No males have previously been discovered for the two species of the genus *Parapetalus*. Careful comparisons were made with Wilson's specimens. Named for Dr. Gordon Gunter.

Family Euryphoridae

Eirgos anurus Bere

Seven from two spadefish, *Chaetodipterus faber* (Broussonet) and four from a Spanish mackerel, *Scomberomorus maculatus* (Mitchill).

Electrophora coryphaenae n. sp.

Figures 94–100

Female.—Carapace orbicular, a trifle wider than long; the lateral lobes rather narrow and rounded. The fourth thoracic segment is narrow anteriorly and bears two lateral wings on the dorsal surface posteriorly. Genital segment circular and forming a narrow waist anteriorly. Abdomen 2-segmented, the anterior segment with lateral lobes. Caudal rami longer than wide and each with five plumose terminal setae.

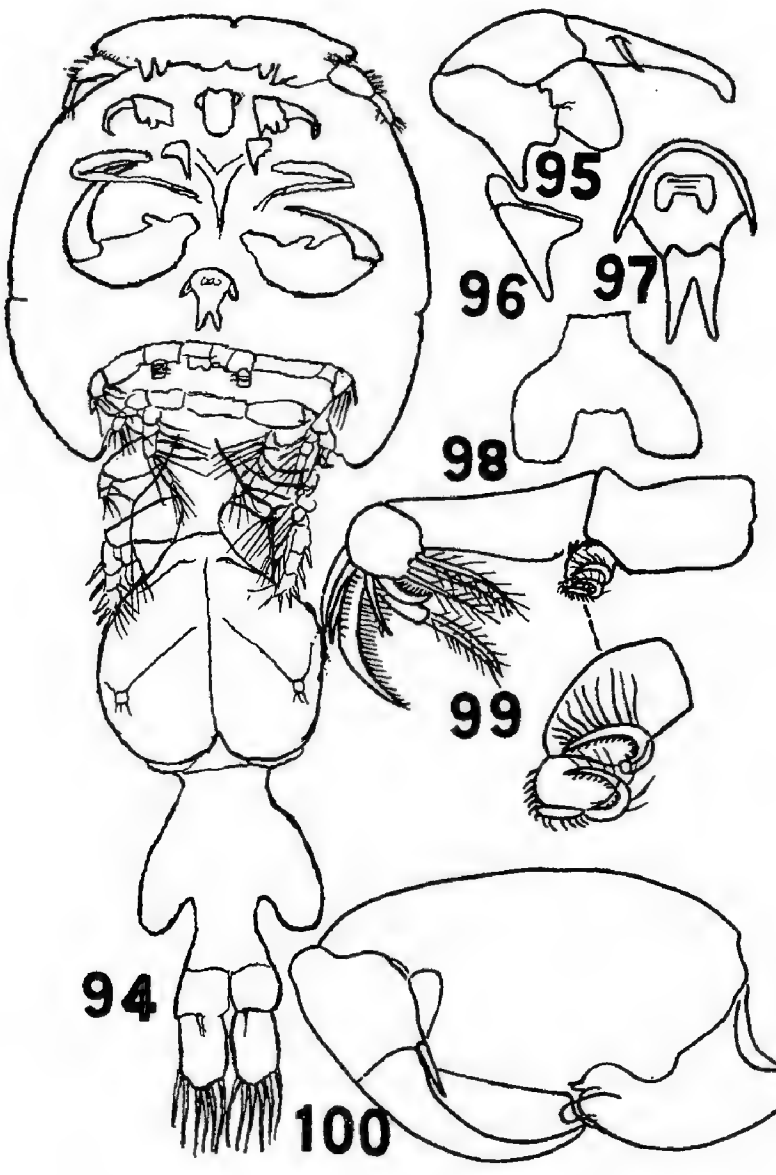
The frontal plates are wide and bear two short appendages on their posterior margins. First antenna with seven spines on margin of first segment and four setae on tip of second. Second antenna with a strong spine on basal segment and terminal hook with a short curved tip and a lateral seta. The maxilla is short, simple and slightly curved. The maxilliped bears a basal papilla, terminal curved claws and a seta. The furca is curved in front, with two lateral spines and two posterior slender processes.

First leg with 3-segmented exopod, basal segment two and a half times as long as wide, second segment circular and armed with five spines and three plumose setae, third segment small, slender, and tipped with two plumose setae; endopod short, 2-segmented; the terminal segment less than half as long as the basal, armed with two recurved plumose and denticulate spines and a row of terminal denticles. Second, third, and fourth legs with exopods and endopods 3–3, 3–2, and 3–2. Fifth legs on ventral side of genital segment, near margin, small, with three terminal setae.

Total length, 5.6 mm.; width of carapace, 2.1 mm.

Host.—A single female was taken from the inside of the operculum of one of eighteen *Coryphaena hippurus* L. Type, U. S. Nat. Mus. No. 92673.

This species differs from *E. brachyptera* Gerstaecker and *E. atlantica* Wilson in the shape and armature of the endopod of the second leg, the furca, the armature of the antennae, the shape of the dorsal plates on the fourth thoracic segment, and the smaller size.



FIGURES 94–100, *Elytrophora coryphaenae*

Female:—94, ventral view; 95, second antenna; 96, first maxilla; 97, furca; 98, dorsal view of fourth thoracic segment; 99, first leg; 100, second maxilliped.

Family Pandaridae

Nesippus alatus Wilson

Twelve from three bonnet-head sharks, *Sphyrna tiburo* (L.) and nine from a nurse shark, *Ginglymostoma cirratum* (Bonnaterre).

Pandarus sinuatus Say

Six from six spot-fin ground sharks, *Carcharhinus limbatus* (Müller & Henle); twenty-three from five bonnet-head sharks, *Sphyrna tiburo* (L.); and three from a sharp-nosed shark, *Scoliodon terrae-novae* (Richardson).

Perissopus communis Rathbun

A male and two females from one of five bonnet-head sharks, *Sphyrna tiburo* (L.).

Family Anthosomidae

Anthosoma crassum (Abildgaard)

Eight from the jaw of a great white shark, *Carcharodon carcharias* (L.) were presented to the writer by Dr. Aaron Seamster. They were taken off Padre Island, Texas.

Lernanthropus amplitergum Pearse

Twelve specimens from thirteen Pensacola red snappers, *Lutianus blackfordi* Goode & Bean.

Lernanthropus brevoortae Rathbun

Twelve Gulf menhaden, *Brevoortia patronus* (Goode) yielded three.

Lernanthropus caudatus Wilson

Fourteen from seventeen sheephead, *Archosargus probatocephalus* (Walbaum).

Lernanthropus giganteus Krøyer

A male and a female from a common jack, *Caranx hippos* (L.).

Lernanthropus gisleri van Beneden

Forty-five from twenty-nine spotted squeteagues, *Cynoscion nebulosus* (Cuvier & Valenciennes).

Lernanthropus longilamina Pearse

Seven from one of thirteen spadefish, *Chaetodipterus faber* (Broussonet).

Lernanthropus longipes Wilson

Two from two channel bass, *Sciaenops ocellatus* (L.) and four from four *Pogonias cromis* (L.).

Lernanthropus pupa Burmeister

Thirteen from thirteen spadefish, *Chaetodipterus faber* (Broussonet).

Lernanthropus rathbuni Wilson

A single female from one of nineteen ten-pounders, *Elops saurus* L.

Family Eudactylinidae

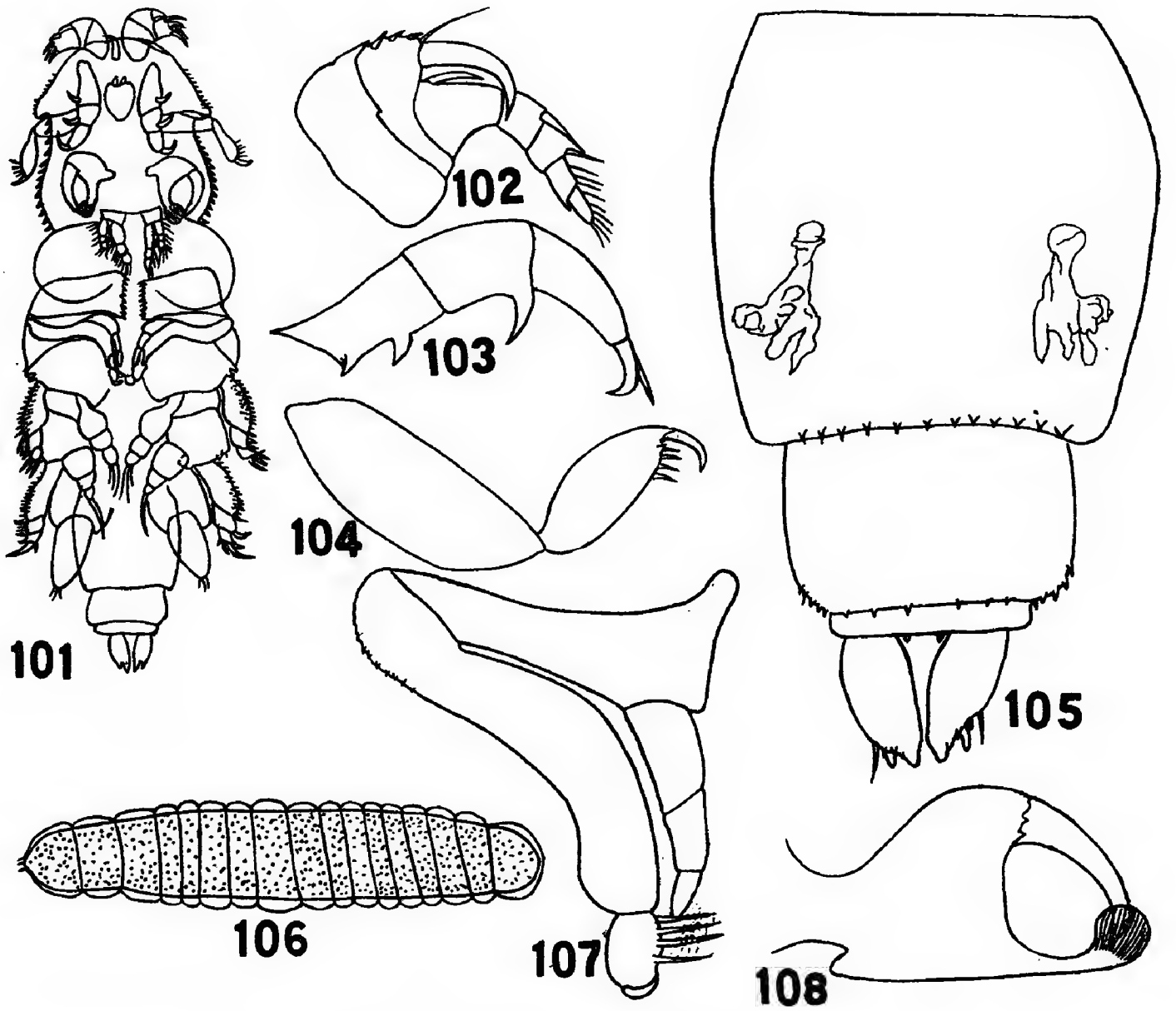
Eudactylina breviabdomina n. sp.

Figures 101–108

Female.—Carapace rounded in front with spinulose margins and blunt, lateral lobes near the anterior margins. The third thoracic segment longest; the second and fifth shortest and about equal in length. Genital segment a fifth narrower than the fourth segment. Abdomen 2-segmented; the first segment three-fourths as wide as the genital

segment and slightly less than half as long; second segment eight-elevenths as wide as the first and less than a seventh as long. Caudal rami six times as long as the preceding segment; tipped with a large and a small lobe, two small spines, and a seta. Egg strings nearly as long as the body and containing 14–20 eggs.

First antenna 7-segmented; basal segment slightly wider than second, with one short spine. Second segment with three short and one very long curved spines; third segment tapered and bearing one spine; fourth segment with one straight spine; three terminal segments setose. Second antenna is 3-segmented; basal segment with two spines, second with one, and terminal segment slender, tapered and with a curved terminal spine and a strong seta. The second maxilla has the basal segment a third longer than the terminal segment, which bears a curved terminal claw and a few setae. The maxilliped has the movable digit with a rather acute tip.



FIGURES 101–108, *Eudactylina breviabdomina*

Female:—101, ventral view; 102, first antenna; 103, second antenna; 104, second maxilla; 105, genital segment, abdomen, and caudal rami; 106, egg string; 107, second leg; 108, second maxilliped.

First legs, small, with two 3-segmented rami. Second legs with endopod elongated and subschelate at tip. Third and fourth legs biramose, the exopods 3-segmented, and

spinose, the endopods 3-segmented, tapered and tipped with two setae. Fifth leg with three terminal setae and spinulose on distal margin.

Length, 1.3 mm.; width, 0.4 mm.; length of egg strings, 1.0 mm.

Host.—*Carcharinus limbatus* (Müller & Henle), on gills; eight females from fifteen sharks. Type, U. S. Nat. Mus. No. 92674.

Male, unknown.

This species differs from *E. minuta* Scott and *E. aspara* Heller, which it resembles most closely, in the shortness of the abdomen, the spines on the first and second antennae, the endopods on the legs, the lateral lobes on the carapace, and the armature of the caudal rami.

Family Pseudocynidae

Krøyeria spatulata Pearse

Nine specimens from five spot-fin sharks, *Carcharhinus limbatus* (Müller & Henle).

Lernaeenicus longiventris Wilson

One from below the eye of one of thirteen dolphins, *Coryphaena hippurus* L.

Pseudocycnus spinosus n. sp.

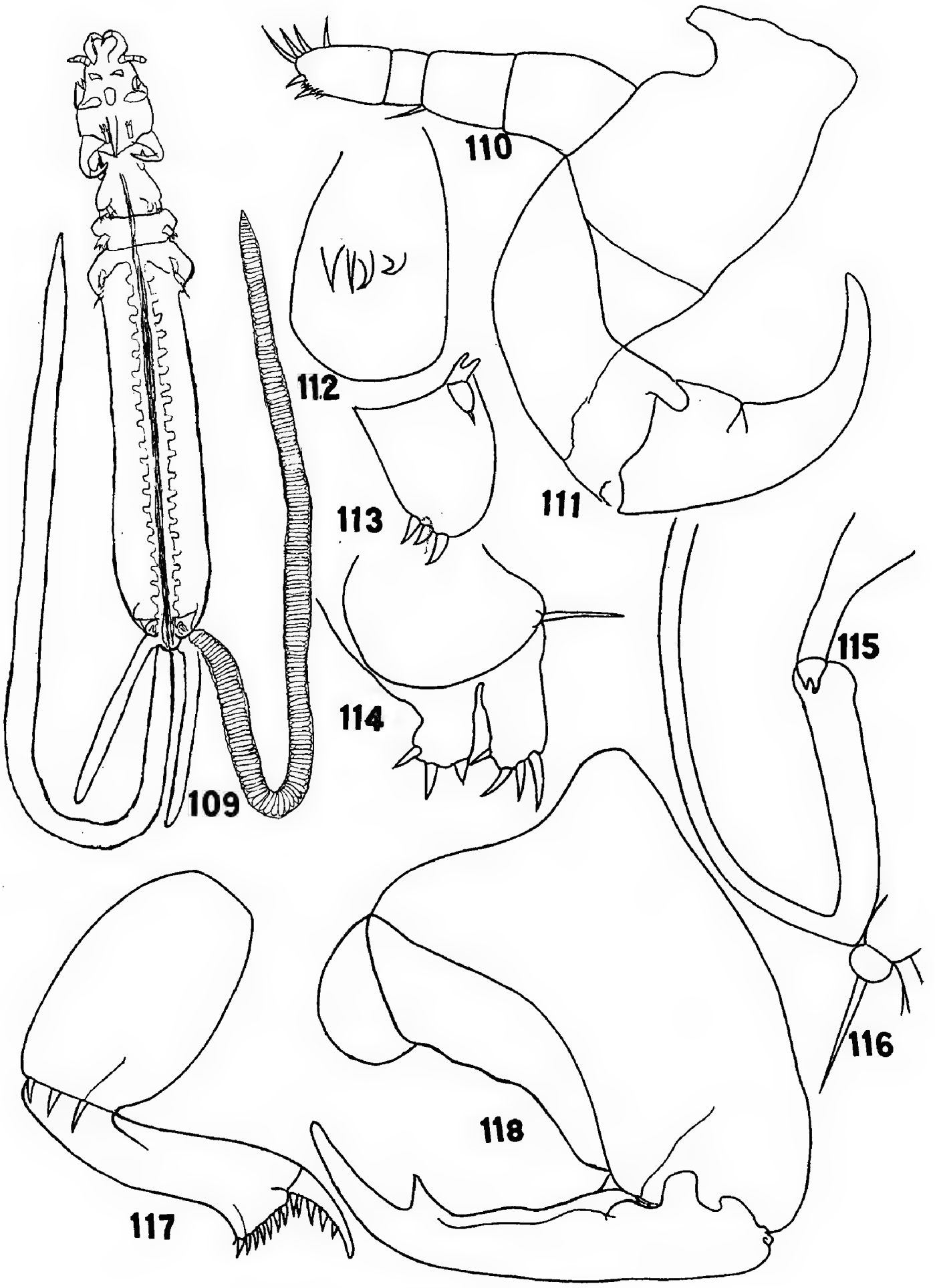
Figures 109–118

Female.—Cephalothorax four-sevenths as wide as long, narrowed in front, bluntly pointed behind. First thoracic segment more than three-fourths as wide as the second; the second, third, and fourth segments gradually wider, with rounded margins. The fused posterior body region is about four times as long as wide. The egg strings are about as long as the body without the caudal appendages and contain about 260 eggs. The abdomen is about half as wide as the genital segment and very short. The caudal laminae are about a third as long as the body, and slender.

The first antennae are 4-segmented, with 2 spines, 4 setae, and 3 or 4 small spinules on the terminal segment. The second antennae project from the front of the head; they are 2-segmented with a strong, curved terminal hook which has a spinule inside its proximal half. The mouth tube is slender and pointed. The first maxillae are slender and bear two setae at their tips. The second maxillae are perhaps the most characteristic feature of this species. The basal segment is robust and bears three terminal spines; the second segment is a little longer, truncated at tip and armed with seven strong spines; the terminal hook bears five spines on its inner margin. The maxillipeds are stout, the terminal hook is curved and bears a sharp claw near its tip.

The first legs are flat, longer than wide, and bear two small hooks and two small spines near their middle. The second legs are biramous, rami without segmentation; exopod with four spines and endopod with three. Third leg biramous; endopod minute, with a single terminal seta; endopod, flat, with three terminal spines. Fourth leg under a flap on the side of the body, consists of a corrugated, conical papilla. Fifth leg consists of a small basal segment, a cylindrical second segment, and a terminal seta.

Total length, 7.3 mm.; width, 1.1 mm.; caudal rami, length 3.0 mm.; egg strings, 7.3 mm.



FIGURES 109–118, *Pseudocycnus spinosus*

Female:—109, ventral view; 110, first antenna; 111, second antenna; 112, first leg; 113, third leg; 114, second leg; 115, fourth leg; 116, fifth leg; 117, second maxilla; 118, second maxilliped.

Host.—A single female was taken from the gill of one of nine bonitos, *Sarda sarda* (Bloch). It differs from *P. appendiculatus* Heller and *P. buccatus* Wilson in the armature of the first, third, and fifth legs, and of the second antennae and maxillipeds, and particularly in the character of the second maxillae. Type, U. S. Nat. Mus. No. 92679.

Cybicola elongata Pearse

Eleven specimens from eighteen king mackerel, *Scomberomorus cavalla* (Cuvier & Valenciennes), ten from two Spanish mackerel, *Scomberomorous maculatus* (Mitchill), and one from one of 28 spotted squeteague, *Cynoscion nebulosus* (Cuvier & Valenciennes).

Family Dichelesthiidae

Hatschekia harkema Pearse

Thirty-three from five spiny boxfish, *Chilomycterus schoepfi* (Walbaum).

Sagum texanum n. sp.

Figures 119–123

Female.—General form, beetle-like. Cephalothorax a little more than one-fourth of the entire length; about one-fourth wider than long; notched in front and expanded into lateral wings that are more or less rectangular with rounded corners behind the antennal area. The second thoracic segment projects at its anteriolateral angle and is turned backward as a short spine. It and the remaining segments are covered by a single dorsal plate, which is covered by small scattered prominences. The third and fourth segments also project backward on each side and are similarly ornamented, but are not wider than the dorsal plate of the second segment and are completely covered by it. The eggs are arranged in two single series; the strings are folded twice and kept on either side under the dorsal plate.

The first antennae are 6-segmented and sparingly setose. The second antennae have a very robust basal segment and a strong terminal claw. First maxilla with two rotund basal segments and a small long and short terminal seta. Second maxilla rather stout with a slender terminal claw. Maxilliped with a stout curved basal segment and a stout curved claw.

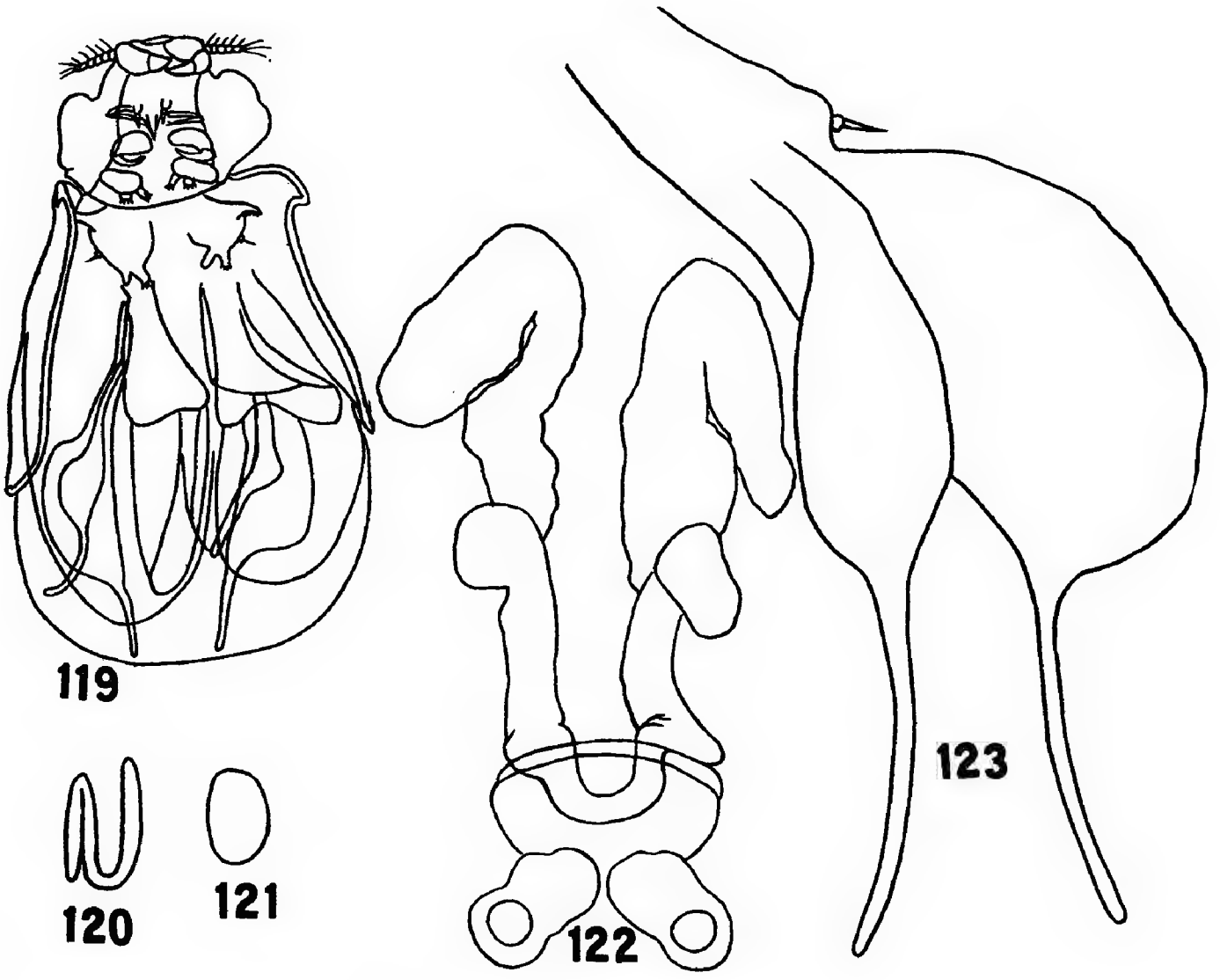
First leg biramous, the rami 1-segmented; exopod short, tipped with four denticles; endopod conical and a little longer; second leg somewhat like first but with a larger base which bears a denticulate lateral process and a seta, rami similar to those of first segment but a trifle longer. Third legs biramous, very wide, with scattered prominences and somewhat coiled laterally. Fourth legs more slender, rami with flat expanded bases and slender tips about as long as the bases.

Length of entire body, 4.8 mm.; width, 2.7 mm.; length of cephalothorax, 1.0 mm.; width, 1.4 mm.

Male.—Unknown.

Host.—Two females were taken from the gills of a hogfish, *Lachnolaimus maximus* (Walbaum), taken in a trawl off Campeche in the Gulf of Mexico. Type, U. S. Nat. Mus. No. 92680.

This species differs from Wilson's (1913) *S. flagellatum* in the armature of the first, second, and fourth legs, the shape of the cephalothorax and the body, and the size. It differs from Krøyer's (1863) *S. angulatus* in the shape of the head, the size and the character of the appendages.



FIGURES 119–123, *Sagum texanum*

Female:—119, ventral view; 120, shape of egg string; 121, egg; 122, genital organs; 123, fourth leg.

Suborder Lernaeopodoida

Family Lernaepodidae

Naobranchia lizae (Krøyer)

Eight from the gills of twenty-two mullet, *Mugil cephalus* L.; two from three spiny boxfish, *Chilomycterus schoepfi* (Walbaum); and one from two batfish, *Ogcocephalus vespertilio* (L.).

Naobianchia spinosa n. sp.

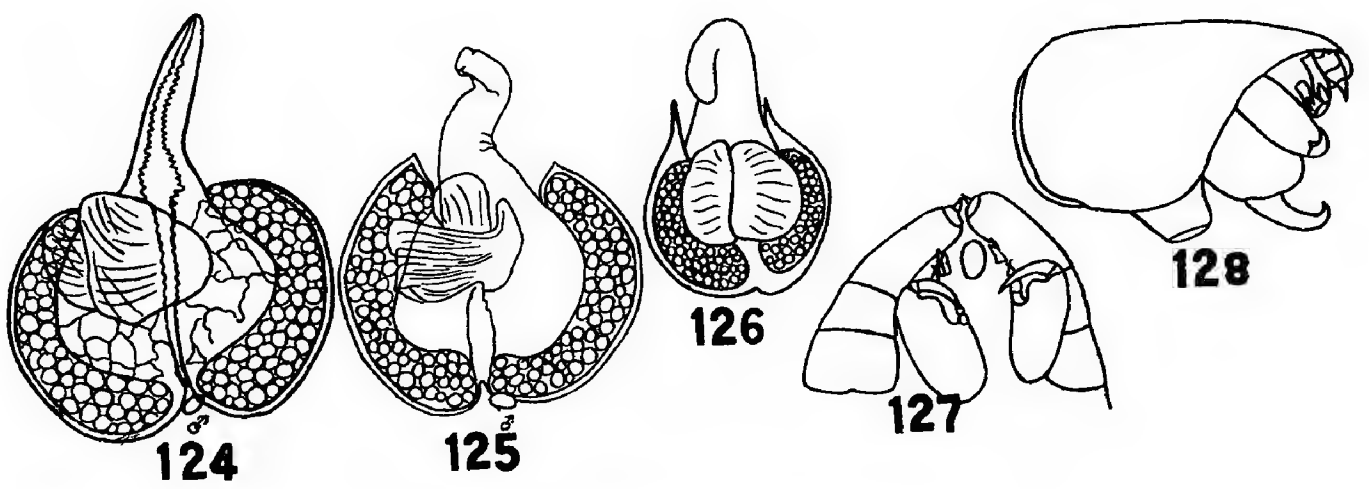
Figures 124–128

Female.—Cephalothorax cylindrical, tapered toward anterior end, shorter than trunk; no dorsal carapace. Trunk in young with sharp anterior processes (hence the specific name, *spinosa*); in adult with two elliptical lateral parts with the anterior

processes less prominent. Egg tubes about the same diameter throughout and contain about 150 eggs; they do not come in contact, but extend completely around the trunk.

First antennae rather stout, 4-segmented, a single short seta on the terminal segment. Second antennae biramous, rami 1-segmented. Mouth tube elliptical. Second maxillipeds with a strong terminal claw and a stout basal segment with a deep sinus opposite the tip of the claw. Maxillae situated a little in front of the middle of the trunk.

Total length, 2.8 mm.; cephalothorax, 1.2 mm.; trunk, length, 1.6 mm.; width, 2.2 mm.



FIGURES 124–128, *Naobranchia spinosa*

Female:—124, mature female; 125, 126, younger females; 127, first antennae, first and second maxillae, mouth tube, and maxilliped. Male:—128, side view.

Male.—Dorsal shield deeper in posterior half. First antennae thick, 3-segmented. Second antennae biramous. First maxilla on the side of the mouth tube. Second maxilla robust but narrower than the maxilliped; both have strong terminal hooks, that on the maxilliped is larger.

Length, 0.18 mm.

Types.—Male and female, U. S. Nat. Mus. No. 92666.

Hosts.—The types were taken from the gill of one of seven rock sea bass, *Centropristes philadelphicus* (L.), captured in a trawl at depths of 12–18 fathoms off Padre Island. Four females and a male were taken from a single individual of the same host and locality. Three females and a male were collected from one of the 29 lizard-fish, *Synodus foetens* (L.), caught off the breakwater at Port Aransas.

This species is characterized by the anterior spinose lateral processes on the trunk of young female individuals and the wide extent of the separate egg tubes.

Brachiella concava (Brian)

Five from eight stingarees, *Dasyatis sabina* (Le Sueur).

Brachiella gulosa Wilson

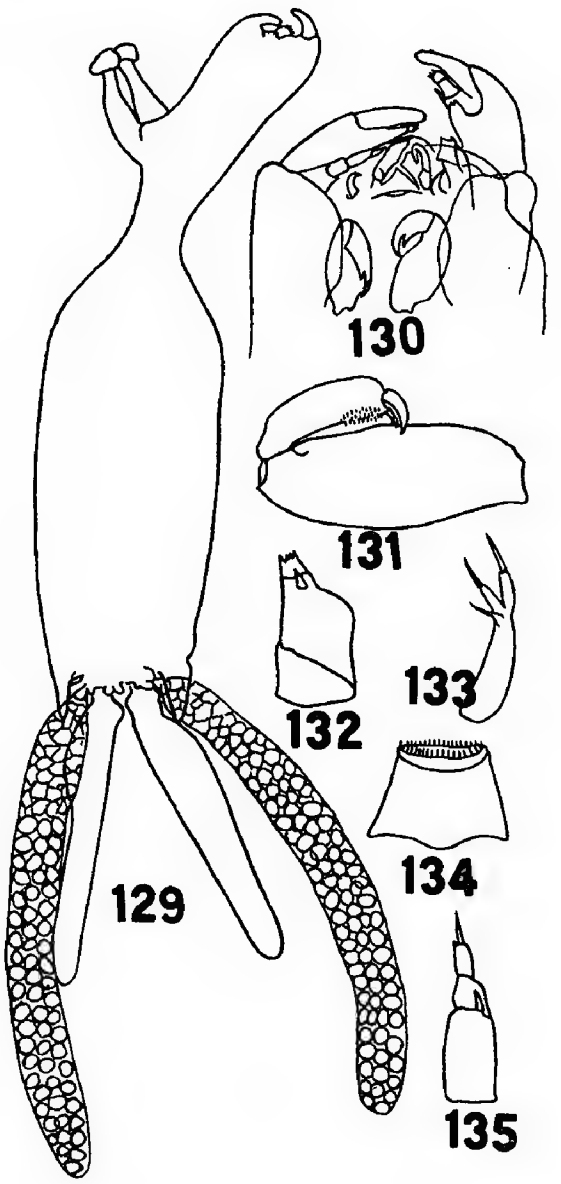
Three from walls of the gill chamber of one of six channel bass, *Scienops ocellatus* (L.).

Brachiella coryphaenae n. sp.

Figures 129–135

Female.—Cephalothorax short, but longer than second maxilla and bulbous at tips. Trunk narrowed anteriorly into a short neck where it meets the cephalothorax, sides nearly parallel posterior to that. Two pairs of posterior processes, the dorsal about a third to a tenth as long as the ventral pair. The short genital process between the bases of these is bilobed on each side and in the middle. Egg sacs a third to a half longer than the ventral processes; eggs in 2 to 5 longitudinal cross rows that number about 30 to 42.

First antenna 3-segmented, a short spine at the tip of the basal segment and a seta at the tip of the terminal segment. Second antenna turned across the anterior end; endopod stout and rounded at tip; exopod short, 2-segmented, truncate, armed with small spines at tip and a stout spine on the second segment. First maxillae slender, tripartite, the terminal parts about equal and the lateral one much smaller; all tipped with a single seta. Basal segment of maxilliped a third as wide as long; second segment half as long as first, spinulose on terminal third of inner margin,



FIGURES 129–135, *Brachiella coryphaenae*

Female:—129, dorsal view; 130, antennae and mouth parts; 131, second maxilliped; 132, second antenna; 133, first maxilla; 134, mouth tube; 135, first antenna.

tipped with a seta and a short hook. Mouth tube wider than long, spinulose along anterior margin.

Length exclusive of caudal appendages, 5.0 mm.; maxillae, 0.6 mm.; caudal appendages, 0.35 mm., 2.1 mm.; egg sac, 2.1 mm. long, 0.33 mm. wide.

Type.—U. S. Nat. Mus. No. 92663.

Male, unknown.

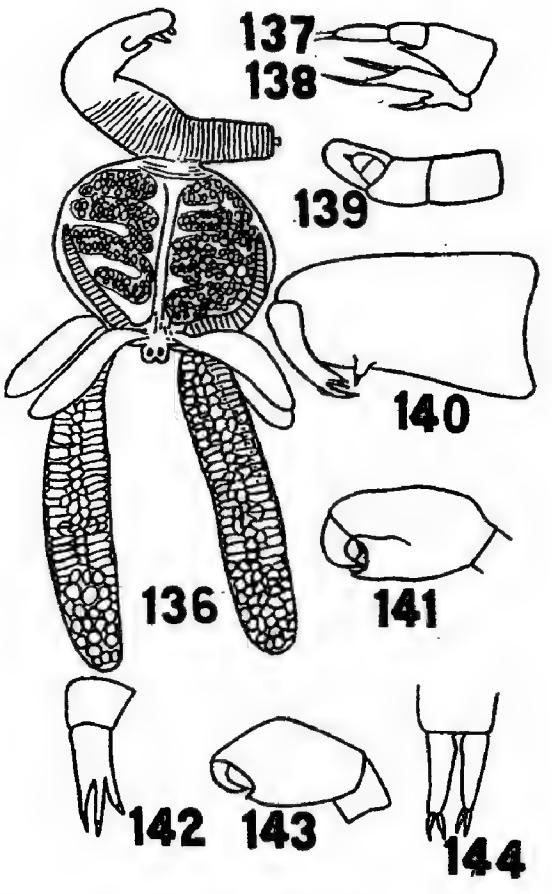
Host.—Eleven females were found on the gills and operculum of thirteen dolphins, *Coryphaena hippurus* L.

This species somewhat resembles *B. insidiosa* Heller, but differs in having a longer neck back of the cephalothorax, longer egg sacs, and greater differences in the length of the caudal appendages. It differs from Wilson's *B. gulosa* in these features and in the armature and proportions of the maxillipeds.

Brachiella rotunda n. sp.

Figures 136–144

Female.—Cephalothorax twice as long as second maxillae. Head without a carapace. Trunk almost spherical, a little wider than long. Two pairs of posterior processes that are about equal in length, about three-fourths as long as trunk, rather plump. Genital process somewhat bilobed, a little wider than long. Egg sacs stout with about 28 rather round eggs down the middle and 39 along the margins; the latter flat through the anterior two-thirds and round through the posterior third.



FIGURES 136–144, *Brachiella rotunda*

Female:—136, dorsal view; 137, first antenna; 138, first maxilla; 139, second antenna; 140, second maxilliped. Male:—141, second maxilla; 142, first maxilla; 143, second maxilliped; 144, caudal rami.

First antenna 3-segmented, with two terminal setae. Second antenna with a 2-segmented base; endopod 1-segmented and bluntly rounded; exopod shorter, 2-segmented, and ending with a short seta. Mouth tube short, broad at base, reaching to second antenna. First maxilla biramous; the exopod and endopod both tipped with two setae. Maxilliped with basal segment twice as long as wide; terminal hook with two small hooklets inside near tip and a seta opposite them on the basal segment.

Cephalothorax, 1.9 mm. long, 0.45 mm. wide; trunk, 1.4 mm. long, 2.0 wide; total length, 4.3 mm.; egg sac, 2.2 mm. long, 0.4 mm. wide; posterior processes 0.95 mm. long, .06 mm. wide; second maxilla, 0.6 mm. long.

Male.—With carapace covering cephalothorax. Posterior portion of abdomen bent under anterior portion, tapering, and ending in two slender conical appendages which are each tipped with two stout setae. First antenna 3-segmented. Second antenna biramose, the exopod rounded, the endopod with a single spine. Mouth tube projecting a little at the anterior end. First maxilla ending in three spinous processes. Second maxillae and maxillipeds similar in size, the former a little wider and with a stouter terminal hook.

Total length, 0.8 mm.

Host.—Nine females and four males were found on the roof of the mouth and gills of eight sea robins, *Prionotus tribulus crassiceps* Ginsburg. Types, female and male, 92662.

This species is somewhat like *B. gulosa* Wilson 1915. The female is characterized by the short and wide trunk, the maxillipeds, the long and wide egg sacs, and the wide, equal posterior processes which are attached about equidistant on the dorsal and ventral surfaces. The male has short first maxillipeds; the caudal appendages are long and have two terminal setae.

Clavellopsis robusta Wilson

Two from fifty-six striped mullet, *Mugil cephalus* L.

Clavellopsis strumosa (Brian)

Forty-two from twenty sheepshead, *Archosargus probatocephalus* (Walbaum).

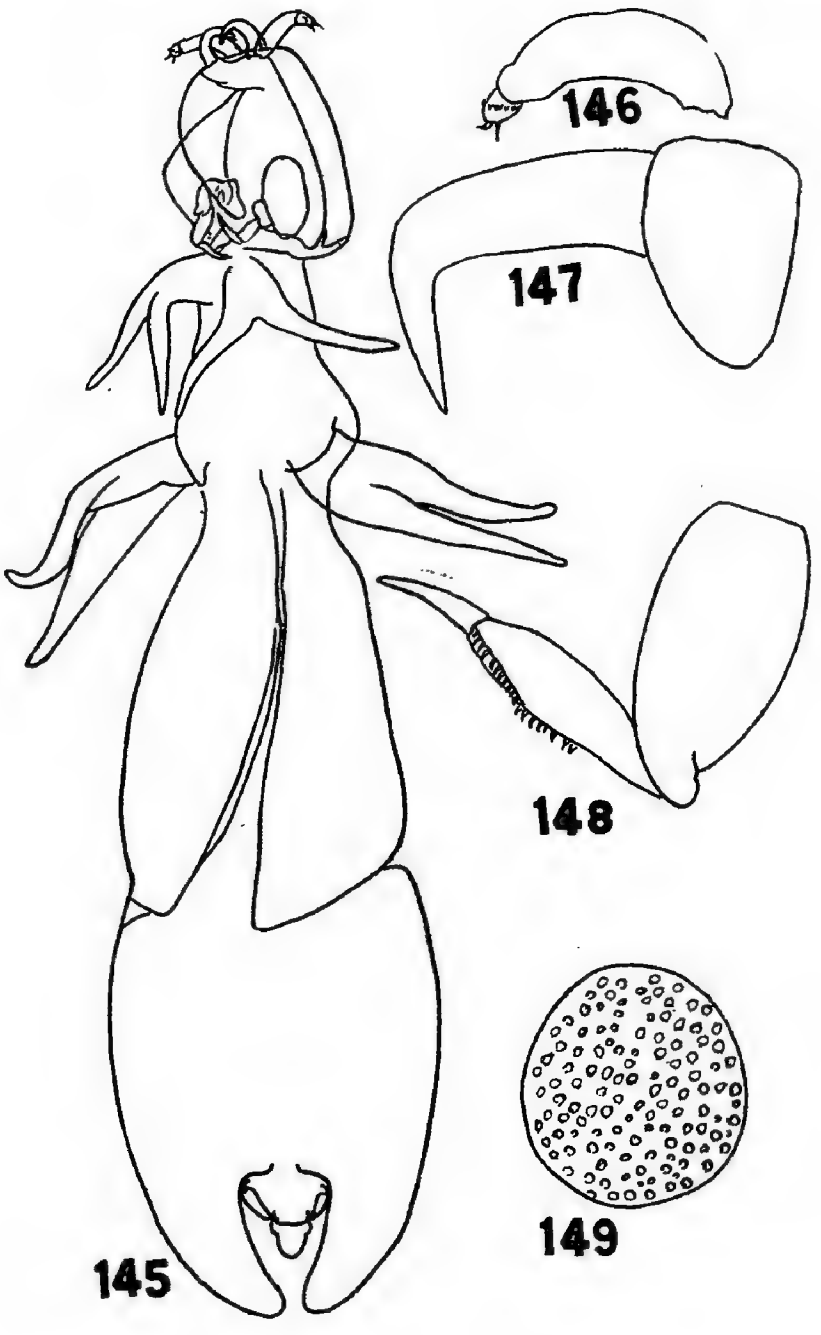
Family Chondracanthidae

Acanthochondria cyclopsetta n. sp.

Figures 145–149

Female.—Head rather rectangular with rounded corners, with a median division into two complete halves. First two metasome segments separate from head; the first narrower and the second about as wide as the head, the other segments wider; dorsal plates not developed; divisions between metasome segments not present. Fifth segment produced posteriorly into two incurved conical processes. Genital segment wider than long, anterior margin nearly straight, posterior widely rounded. Abdomen longer than wide; ellipsoidal, with the anterior half a trifle wider. Abdomen reaches slightly more than half the length of the processes on the fifth segment.

First antenna 2-segmented; the first segment cylindrical, about eight times as long as the second, which bears a row of lateral denticles and a terminal small hook and seta. Second antenna with a wide basal segment and a longer, sharply curved terminal claw. Maxillipeds with a long, stout basal segment, a more slender denticulate second segment, and a terminal claw. First two pairs of legs, unsegmented, biramous, and elongate; the second pair extend more than half the length of the third thoracic segment; first pair two-thirds as long as second; endopods and exopods nearly equal in length. The egg strings were broken. The eggs measured 0.11 mm. in diameter.



FIGURES 145–149, *Acanthochondria cyclopsetta*

Female:—145, ventral view; 146, first antenna; 147, second antenna; 148, second maxilliped; 149, egg.

Length, 9 mm.; width, 2.3 mm.

Male.—Attached to female, but lost.

Host.—Gill of one of five *Cyclopsetta chittendeni* Norman. Off Padre Island, 18 fathoms. Type, U. S. Nat. Mus. No. 92664.

This species differs from others in the genus *Acanthochondria* in its great length and slender body. Also, the legs are long; the carapace is completely divided by a median suture, as is the third thoracic segment.

Family Sphyriidae

Paeon ferox Wilson

One from the gills of a bonnet-head shark, *Sphyrna tiburo* (L.).

Order Isopoda

Suborder Cymothoidea

Family Cymothoidae

Nerocila acuminata Schioedte & Meinert

Nineteen specimens were collected from the following hosts:—eleven *Bagre marina* (Mitchill), 1; fourteen *Diplectum arcuatum* Ginsburg, 2; 56 *Galeichthys felis* (L.), 11; 31 *Mugil cephalus* L., 2; and 5 *Promicrops itiaria* (Lichenstein), 3.

Anilocera laticauda Milne Edwards

Three from the following hosts:—1 from 17 *Prionotus tribulus crassiceps* Ginsburg; 1 *Sardinella anchovia* (Cuvier & Valenciennes), and 6 *Sciaenops ocellatus* (L.).

Cymothoa oestrum (L.)

Two specimens that agreed with Richardson's description, except that they possessed eyes, were taken from eleven *Bagre marina* (Mitchill) and a *Tarpon atlanticus* (Cuvier & Valenciennes).

Livoneca texana n. sp.

Figures 150–157

Female.—Head rounded in front and slightly indented in the middle on the posterior border; slightly set into the first thoracic segment. Eyes are rather narrow and elliptical. Antennae of the two sides separated at bases. First pair 8-segmented; second pair 16-segmented, reach to end of anterior third of first thoracic segment. First six thoracic segments decrease slightly in length from anterior to posterior; epimera of segment one to six increase progressively in size. Legs increase slightly in size from front to rear; dactyli strongly hooked. Abdomen in mature individual as wide as thorax; somewhat immersed in thorax; lateral angles bent backward and pointed. Telson twice as wide as long, curved inward slightly in the middle of the posterior margin. Uropoda do not reach beyond the telson. Palp of mandible rather slender, 3-segmented. First maxilla, slender, with three small, sharp terminal spines. Second maxilla more robust, with a minutely spinulose median margin, two curved terminal spines and a small papilla.

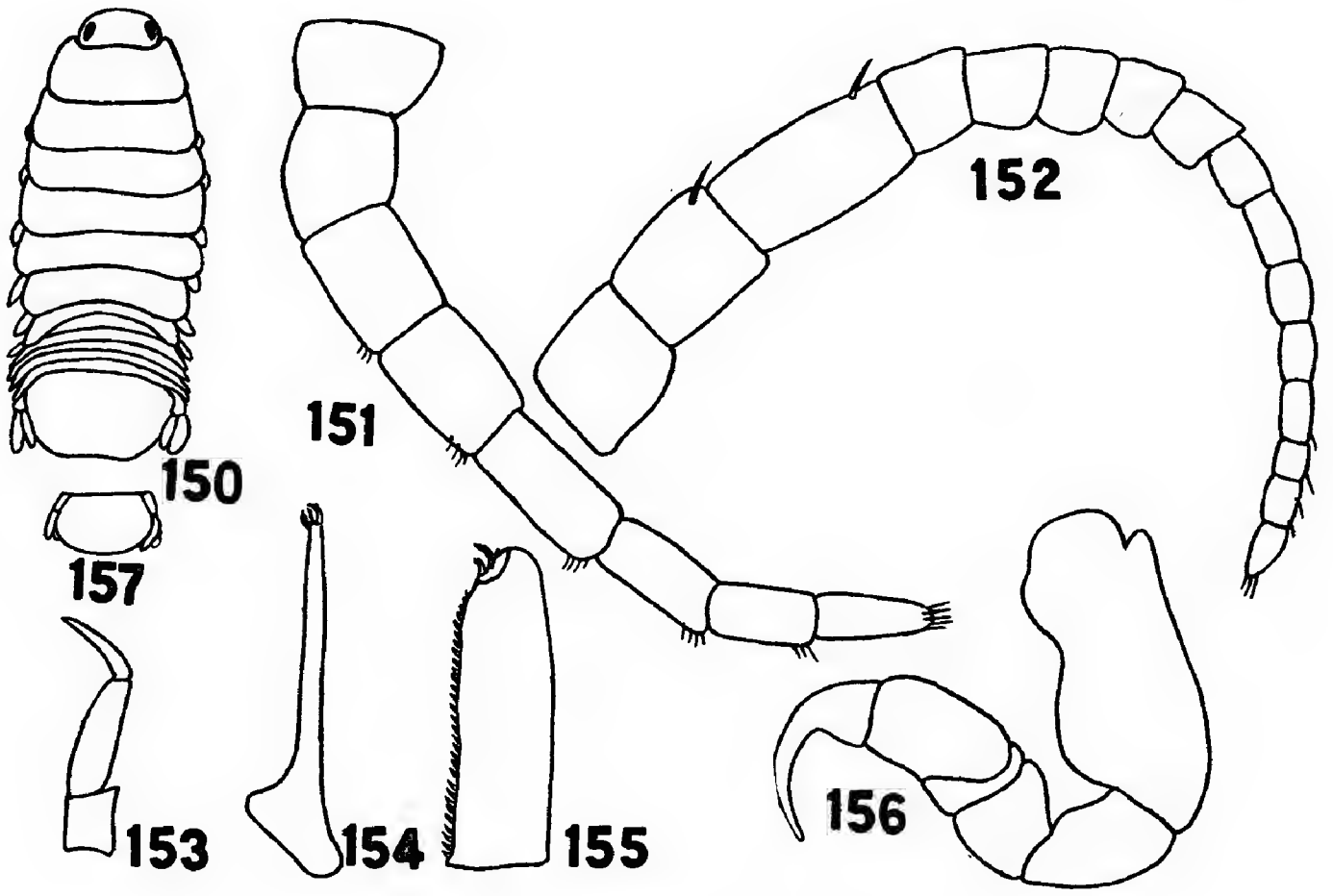
Length, 19–23 mm.; width, 8–12 mm.

Male.—Smaller than female, more slender. Second antenna reaches to middle of second thoracic segment. Telson rounded posteriorly.

Length, 9–11 mm.; width, 5 mm.

Hosts.—Thirteen females, four of which carried attached males, were taken from the gills of eighteen lizard-fish, *Synodus foetens* (L.), in a shrimp trawl at a depth of 12–18 fathoms off Padre Island in the Gulf of Mexico. Two females were also taken from 17 sea bass. *Centropristes philadelphicus* (L.), and a female from the gill of one of 11 gaff-topsail catfish, *Bagre marina* (Mitchill).

Types.—Female and male, U. S. Nat. Mus. No. 92732.



FIGURES 150–157, *Livoneca texana*

Female:—150, dorsal view; 151, first antenna; 152, second antenna; 153, mandibular palp; 154, first maxilla; 155, second maxilla; 156, first leg; 157, male telson and last legs.

This isopod differs from Richardson's (1905) and Van Name's (1925) species in the shape of the telson, the longer and more numerous segments in the second antennae and the comparative length of the thoracic segments.

Family Sphaeromidae

Ancinus depressus (Say)

One from 31 striped mullet, *Mugil cephalus* L.

Suborder Bopyroidea

Family Bopyridae

Probopyrus latreuticola (Gissler)

This bopyrid was quite common in the gill chamber of a shrimp *Latreutes ensiferus* Stimpson, occurring in the Sargassum that floated by the Institute of Marine Science dock on Aransas Pass.

Probopyrus pandalicola (Packard)

A male and a female in the gill chamber of a shrimp, *Palaemonetes pugio* Holthuis, that was caught in the vicinity, were presented to the writer by Martin D. Burkenroad.

Discussion

The collections in the Gulf of Mexico are remarkable for their lack of copepods in the Genus *Hatschekia*. The writer (1951) at Bimini in the Gulf Stream found nine species in that genus; Wilson (1913) in the West Indies found six but none at Tortugas (1935). In Florida Bere (1936) collected one, and the writer during the present investigation, one. Caligids were common wherever collections were made. Argulids were fairly abundant on the coast of Florida, where Bere (1936) found six species but they were absent or yielded only one at other localities. They appear to be largely confined to fresh or brackish water. The collections of barnacles and isopods are too limited to merit discussion.

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Fishes of the Family Carangidae of The Northern Gulf of Mexico and Three Related Species

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U. S. Fish and Wildlife Service

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This paper is the result of a study of the fishes of the Gulf coast of the United States which is being continued. It deals with the family Carangidae which includes such well known food and game fishes as the pompanos, the amberjacks and the cavallos.

The species which have been recorded from, and those which have been found during this study to occur within the geographic limits of the the coast extending from the mouth of the Rio Grande in Texas to Cape Romano, Florida, are here treated. While this arbitrarily fixed geographic extent is limited, it includes the large majority of the well authenticated species of this family found in the western Atlantic, that is, excluding species, or records in current lists, that are of doubtful validity.

Three species not now known from the region under consideration are here included for comparative purposes, as follows. *Alectis crinitus* is one of a group of three genera, including *Selene* and *Vomer*, the species of which undergo extraordinary changes with growth. These changes have been determined and are hereafter described insofar as the available material permitted. The other two species, *Seriola fasciata* and *Trachinotus marginatus* are here included; because in order to understand the species of these two genera occurring in the Gulf, it was found necessary to make a detailed study of all the available western Atlantic specimens. The accounts of *Seriola* and *Trachinotus* given below virtually represent reviews of the species of those two genera found on the east coast of the United States and possibly include all the western Atlantic species.

The accounts given here are based on data determined first hand by a study of specimens of every species. The specimens examined are chiefly those in the National Museum collection and those obtained by the U. S. Fish and Wildlife research boat *Pelican*, supplemented by some specimens from other sources. Numbers given in parenthesis in listing specimens examined, refer to U. S. National Museum numbers.

Two of the results of the present study, among others, may be especially mentioned here as follows: (1) Four species of amberjacks are here definitely distinguished from the east coast of the United States, and these very likely include all the species found here. (2) Based on the samples examined, the so-called "permit" apparently does not represent a distinct species; but this name is applied to large specimens of *Trachinotus falcatus*, perhaps also to large specimens of *T. carolinus*.

As in other papers resulting from this continued study, which have been published or are now in press, the family description includes the characters common to the species and genera here treated and are not repeated under their accounts. Likewise, when a genus contains two or more species, the characters common to the species are stated under the genus and are not repeated under their accounts. Also, the definition of the family and those of the genera apply only to the species included in this paper and are not formulated on a world wide basis. As a further means of promoting brevity, and to prevent the cluttering up of the account with non-essential matter, only the important characters that distinguish the genera and species are described.

Depending on the available material, intraspecific variability of the essential characters has been determined on a moderate number of specimens and stated under the accounts of the species, except in difficult and critical cases where frequency distributions are given in tabular form.

Measurements are expressed as a percentage of the standard length, except where otherwise stated. Given lengths of specimens refer to the distance from tip of snout to tip of upper caudal lobe.

Color descriptions are based on preserved specimens.

Synonymies include only references to general works, other important references and records from the northern Gulf coast. No attempts have been made to compile complete bibliographies to the genera and species. As a consequence, the entire geographic range and the recorded maximum size to which the species attain are omitted from their accounts. (Indeed, on account of questionable identifications, records of size in some instances are doubtful.) But under the accounts of each species, the localities from which specimens were examined and their maximum sizes are stated.

According to authors, some of the species, such as *Caranx hippos*, *Selar crumenophthalmus*, and others, have a wide distribution in the Atlantic and Pacific. In my study of the species for this faunal work, no attempt was made to study specimens from the recorded entire geographic range of such species, and their possible population differences. My studies were confined to and the following accounts are based on specimens from the western Atlantic.

Family CARANGIDAE
Amberjacks, Cavallos, Pompanos and others

Form differing widely with the genus from slender to excessively deep and from moderately to excessively compressed. Caudal peduncle of medium width to notably slender, depressed to compressed, with a median lateral ridge present or absent; a short ridge close to and above lateral line and a similar ridge below, placed partly on peduncle and partly on caudal fin, present in some genera (present in the smaller specimens of *Caranx*, becoming more pronounced with growth; also in the largest specimens examined of *Vomer* and *Alectis;* absent in specimens examined of the other species; in some of these species perhaps developing in larger specimens than those examined). Adipose eyelid moderately to well developed. Maxillary narrow to broad; supplemental maxillary present or absent; end of maxillary falling short of a vertical through anterior margin of eye, or reaching through its posterior margin. Mouth terminal to superior, of moderate extent. Teeth small to minute, subequal, or outer teeth in jaws moderately enlarged; no canines; those in jaws in moderate bands, differing to one row; present or absent on vomer, palatines or tongue, depending on the species (all teeth disappearing with growth in *T. carolinus* and *T. falcatus*). Hard part of opercle with a small emargination above, the opercle above and below emargination widely or rather narrowly rounded, not spinous; soft part bridging emargination with a dark or black spot in several species; preopercle not serrate, smooth or slightly crenate. Gill opening large, branchiostegal membrane forming a slight fold across isthmus under eye or a little in advance. Pseudobranchiae well developed, except in *Trachinotus*. Gill rakers moderate in length and number to slender and numerous. Position of anus differing with species from near first anal spine to near ventral base. Scales small to minute; body altogether scaled or nearly so, except in *Vomer setapinnis* and *Alectis crinitus;* cheek, opercle and antedorsal area scaled or naked; interorbital and interopercle scaled in *Selar*, *Decapterus* and *Trachurus*, scaleless in other genera; rest of head naked; spinous dorsal scaleless, other fins scaled or not depending on species. Anterior part of lateral line usually somewhat sinuous, curved, differing from

a high arch to very slightly curving; posterior part armed with slightly or strongly developed scutes or unarmed; an accessory lateral line beginning nearly over preopercular margin, running upward, curving a little below dorsal contour and continued backward for a distance differing with the species. Procumbent dorsal spine present, in the young slightly to well developed, generally becoming reduced with growth and also covered by thick skin and often hardly preceptible in large specimens. With two separate dorsal fins; first dorsal of moderate height or very low; with 5–8 spines, some or all greatly reduced in length, most of them rather flexible or all pungent, connected by membrane or disconnected, depending on the species; midback at base of spinous dorsal with a groove continuous or interrupted, the spines folding backward into groove (the last 2 spines in some species usually or often lying flat against the back and hidden in the groove, and unless examined with care their presence might be missed); second dorsal with one spine, more or less flexible, closely adherent to following 18–40 rays; structure of dorsal changing markedly with growth, in the young, of some species at least, the spines stouter, relatively longer and pungent, instead of flexible, the single spine of the second dorsal similar to those of the first dorsal, and the two fins more or less connected, continuous in some species; with growth the two fins becoming well separated, the one spine of the second dorsal becoming flexible and intimately merging with rest of fin; spines of first dorsal becoming relatively reduced, sometimes strikingly so, some of them becoming thin and more or less flexible, part of them (in *Vomer setapinnis*) or all (in *Alectis crinitus*) virtually disappearing with growth. Anal similar to dorsal in structure and development, in grown specimens typically consisting of two separated spines, well disconnected from soft part of fin, and one spine, flexible or pungent, intimately connected with following 15–30 rays; in young, of some species at least, the three spines well developed, stout, pungent, connected by membrane and the anal fin continuous; with growth the two anterior spines becoming disconnected and removed at some distance from rest of fin, becoming reduced in relative length, one or both disappearing in some species. Last dorsal and anal ray more or less thicker than preceding rays; becoming detached from rest of fin to form separate finlet in two genera (finlet consisting of one ray in *Decapterus,* of two rays in *Elagatis;* in *Oligoplites* most rays in form of partly attached finlets). Anterior dorsal and anal rays only a little elevated or excessively so, the degree of elevation differing with the species and changing intraspecifically with growth. A fold of skin at base of dorsal and anal, the two fellows forming a troughlike sheath for base of fin, well or moderately developed anteriorly, absent or moderately developed posteriorly; scaled; obsolescent in some species. Ventral short to long, its outer angle on a vertical differing from well in front of the lower pectoral angle to a little behind. Pectoral with 15–23 rays, hardly to notably falcate, short to notably long. Caudal well to notably forked or lunate, its length differing with the species.

Contrary to many other fishes, in many species of this family the body depth is proportionately greater in the young and decreases with growth.

Dorsal and anal finlets evidently appeared independently in different lines of descent within the family. Of the two Gulf genera having an entirely detached finlet, *Elagatis* is evidently nearly related to *Seriola,* and *Decapterus* is near *Selar;* but are rather remote from each other. *Oligoplites* which has a number of only partly detached finlets is still wider apart from either *Elagatis* or *Decapterus.*

This family is notably heterogeneous, including genera which differ widely in structure and appearance. Some attempts have been made by authors to divide the Carangidae in a number of subfamilies; but such attempts did not prove satisfactory for two reasons: (1) Some of the characters hitherto used for this purpose are unsatisfactory. (2) The presence of transitional genera prevents the drawing of well marked lines between the groups which have been proposed as subfamilies.

Key to the genera and species

1a. Maxillary protractile. Scales normally rounded, those in lateral line variously modified. Fin rays having the prevalent structure and attachment to one another, except one dorsal and anal finlet present in *Elegatis* and *Trachurus*.

2a. Lateral line without spinous scutes, the posterior scales sometimes with a slight or moderate longitudinal ridge; body elongate or deep, but anterior contour of fish as usual, tapering forward to the rounded or blunt snout; and gill rakers on lower limb not more than 20; the three characters going together. Pectoral rather short, hardly or slightly falcate. Dorsal and anal lobes very moderately raised to very long.

3a. Snout having the usual piscine shape, tapering forward, subconical. Maxillary broad, its width subequal to eye in the larger specimens, with a well developed supplemental maxillary. Spindle shaped, elongate to oblong, depth 24–42. First dorsal with 6–8 spines connected by membrane, except last one or two. Second dorsal having 7–19 more rays than anal.

4a. Without detached dorsal and anal finlets. First dorsal with 7–8 spines, 6 in very large specimens ..... *Seriola* (p. 53)

5a. Total number of gill rakers on both limbs of outer gill arch, including a tubercle at one or both ends of the arch, 25–28, or 7–9+18–20; the number hardly changing with growth (growth change determined only for *falcata*). Scales 122–137. Dorsal rays 28–32.

6a. In small specimens: nuchal band oblique, running from eye to beginning of first dorsal; body bands usually 5, sometimes 6, moderately split transversely by a lighter area; all bands disappearing with growth; dorsal spines 7, except 8 in specimens 14–15 mm. In the larger specimens: preanal 59.5–62.0; dorsal lobe 21.5–27.5; anal lobe 18–20; depth 34.5–40.0 ..... *Seriola falcata* (p. 58)

6b. In small specimens (large specimens not examined): nuchal band moderately oblique, not reaching beginning of dorsal; body bands 7, often widely split transversely by a lighter area; dorsal spines 8 ..... *Seriola fasciata* (p. 61)

5b. Total number of gill rakers and tubercles on first arch usually 21–24, sometimes 25, or 5–7+15–19, some of the gill rakers at both ends of arch becoming so reduced with growth as to be virtually indistinguishable in most of the larger specimens, the number of well defined gill rakers in such specimens 2–4+11–14 (while gill raker count intergrades somewhat in the smaller specimens, the larger fish are separable discretely by this character). Scales 141–187.

7a. In the larger specimens: preanal 60–63; dorsal lobe 14–16; anal lobe 12.5–13.5; depth 32–35. Dorsal spines 7. Dorsal rays 30–35. Scales 141–163 ..... *Seriola dumerili* (p. 63)

7b. In comparable specimens: preanal 67.0–69.5; dorsal lobe 14.0–16.5; anal lobe 10.5–13.0; depth 25.5–30.0. Dorsal spines usually 8, sometimes 7. Dorsal rays 33–40. Scales 160–187 ..... *Seriola zonata* (p. 64)

4b. A detached finlet behind dorsal and anal. First dorsal with 6 spines ..... *Elagatis bipinnulatus* (p. 67)

3b. Snout having a characteristic appearance, notably foreshortened, broad, blunt. Maxillary rather narrow, subequal to pupil; without a definite supplemental maxillary. Oblong to notably deep, depth 32–74. First dorsal with 6 spines (sometimes 5 in *Trachinotus carolinus*), becoming detached with growth; second dorsal having 1–4 rays more than anal ..... *Trachinotus* (p. 69)

8a. Dorsal rays 18–21. Anal rays 16–18.

9a. Small specimens, up to 125 mm. in standard length, very deep bodied, depth 54–72, becoming oblong with growth (see table 12); dorsal and anal lobe in the larger specimens moderately long, that of dorsal about reaching caudal base, 36–49. Body without cross bars ..... *Trachinotus falcatus* (p. 72)

9b. Body oblong, depth not more than 50 in comparable small specimens, increasing moderately in depth with growth; dorsal and anal lobe in large specimens excessively prolonged, that of dorsal reaching considerably beyond caudal base, 45–82. Body with comparatively long cross bands, except in small specimens ..... *Trachinotus glaucus* (p. 76)

9c. Body oblong, depth 46–53 in 7 specimens 108–225 mm. (depth somewhat increasing with growth in the specimens examined); dorsal and anal lobes comparatively moderate, not reaching a vertical through caudal base in largest specimens examined. Body with short cross bands or transversely elongate spots ..... *Trachinotus marginatus* (p. 79)

8b. Dorsal rays 23–27. Anal rays 20–23. Body usually oblong except at a certain size range (see table 15); dorsal and anal lobe moderately elevated. Without cross bands ..... *Trachinotus carolinus* (p. 79)

2b. Posterior straight part of lateral line with well developed, spinous scutes, when scutes very moderate or obsolescent anterior contour of fish notably elevated, almost vertical or moderately oblique (in *Vomer* and *Selene*), or gill rakers 31–35 on lower limb (in *Chloroscombrus*).

10a. First dorsal differing in size, but having the prevalent shape, the spines graduated both ways, the anterior spines increasing in length backward, the posterior ones decreasing, connected by membrane, except last one or two spines partly or wholly disconnected; when last 4 dorsal spines short and disconnected (in large specimens of *Caranx hippos*), scutes well developed and body comparatively slender, depth 29. The two separated anal spines hinged and persistent with growth, except virtually absent in one specimen examined of *Uraspis heidi*. Fins not strikingly changing with growth.

11a. Interorbital and interopercle partly or wholly scaled. Pectoral reaching a vertical through beginning of soft anal or falling short. Anterior curve in lateral line low or moderately rising. Caudal shorter than head. Depth 19–30.

12a. Scales in anterior part of lateral line rounded, not larger than adjacent normal scales, not transversely expanded. Shoulder girdle with 2 thick papillae.

13a. No finlet behind dorsal and anal. Lower papilla on shoulder girdle larger than upper. Pectoral reaching to over beginning of soft anal in large fish. Depth 25–29 ..... *Selar crumenophthalmus* (p. 83)

13b. A finlet behind dorsal and anal present. The two papillae on shoulder girdle subequal. Pectoral falling short of a vertical through beginning of soft anal. Depth 19–23 ..... *Decapterus punctatus* (p. 85)

12b. Scales in anterior part of lateral line transversely expanded, similar in shape to posterior scutes, except not keeled nor spinous. Shoulder girdle without papillae. Pectoral reaching to over beginning of soft anal in large fish. Depth 25–30 ..... *Trachurus lathami* (p. 87)

11b. Interorbital and interopercle scaleless. Pectoral reaching beyond a vertical through beginning of soft anal. Anterior curve in lateral line well developed, comparatively high. Caudal subequal to or longer than head, sometimes slightly shorter. Depth 29–54.

14a. Lateral line with well developed scutes. Ventral contour not notably more curved than dorsal profile. Gill rakers on lower limb 14–28.

15a. Vomerine teeth present. Outer teeth in jaws moderately enlarged. Two short keels on caudal peduncle (not evident in small specimens). Depth 29–36 in the larger specimens. Teeth in upper jaw in more than one row. Spinous points of scutes directed backward. Widest part of maxillary wider than pupil. Cheek largely scaled. The two separated anal spines present. Dorsal spines normally

8. Ventral reaching approximately half the distance from its base to anal origin. Mouth cavity without white areas ..... *Caranx* (p. 90)

16a. Anal rays 15–17. Dorsal rays 19–22. Gill rakers on lower limb (excluding rudiments) 14–16. Maxillary ending under posterior margin of eye. Dorsal and anal lobe high. Scutes 30–42. Curve in lateral line long. Body rather deep.

17a. Chest scaled ..... *Caranx latus* (p. 92)

17b. Chest scaleless ..... *Caranx hippos* (p. 93)

16b. Anal rays 19–24. Dorsal rays 23–27. Gill rakers 17–28. Maxillary ending under anterior margin or middle of eye. Dorsal and anal lobe moderate or moderately high.

18a. Scutes 20–31. Gill rakers 17–21. Dorsal rays 25–27. Anal rays 22–24. Chord subtending curve in 1.1 moderately shorter than straight part. Body rather deep ..... *Caranx bartholomaei* (p. 95)

18b. Scutes 45–54. Gill rakers 25–28. Dorsal rays 23–24. Anal rays 19–21. Chord subtending curve in 1.1. about one and two-thirds times in straight part. Body rather slender ..... *Caranx crysos* (p. 96)

15b. Vomerine teeth absent. Outer teeth not enlarged. Caudal peduncle without keels. Depth 40–47 in the larger specimens.

19a. Spinous points of scutes directed backward. Upper jaw with one row of teeth. Curve in 1.1. short. Widest part of maxillary less than pupil diameter. Chest scaled. Cheek largely naked. Ventral reaching less than half the distance from its base to origin of soft anal. The two disconnected anal spines present. Dorsal spines usually 7. No white color within mouth cavity ..... *Hemicaranx amblyrhynchus* (p. 98)

19b. Spinous points of most scutes directed forward. Upper jaw with 2 rows of teeth. Curve in 1.1. long. Widest part of maxillary a little wider than pupil. Chest scaleless. Cheek scaled in large part. Ventral reaching a little beyond origin of soft anal. The two disconnected anal spines virtually absent. Dorsal spines 8. Mouth cavity with large white areas ..... *Uraspis heidi* (p. 99)

14b. Lateral line with a few weak or rudimentary scutes. Arch of ventral contour deeper than that of dorsal. Gill rakers 31–35. Body notably compressed ..... *Chloroscombrus chrysurus* (p. 101)

10b. First dorsal reduced; the last four spines at least, short, disconnected, subequal, the fin partly or wholly disappearing in the larger specimens of two species. The two separated anal spines short in young, disappearing with growth. Fins strikingly changing with growth, depending on the species, except pectoral and caudal undergoing about a normal growth change. Scutes moderate or virtually undeveloped. Depth 48–63 in the larger specimens. Opercle scaleless.

20a. Cheek partly scaled. Scutes moderately developed with moderate spinous points. Anus about midway between ventral base and normal position of first anal spine. Ventral moderately long in large specimens. D 18–19. A 15–16. Gill rakers on lower limbs 14–16. The two separated anal spines hinged. Dorsal spines not filamentous in the young, short and pungent, disappearing with growth. Ventral notably prolonged in young, nearly equalling standard length. Anterior dorsal and anal rays excessively prolonged in the young and in medium sized specimens ..... *Alectis crinitus* (p. 104)

20b. Head altogether naked. Scutes very moderately developed, without spinous points, or rudimentary. Anus placed near ventral base. Ventral very short in grown specimens. D 20–23. A 17–20. Gill rakers 23–29. Separated anal spines fixed.

21a. Anterior contour nearly vertical. Anterior dorsal and anal lobe slightly or hardly elevated. Scutes few and moderate, moderately keeled and not spinous. Upper part of body largely scaleless. Anterior 4 dorsal spines virtually disappearing in large specimens; filamentous in young, the second and longest not reaching caudal base. Ventral in young moderate, not reaching origin of soft anal ..... *Vomer setapinnis* (p. 109)

21b. Anterior contour oblique. Dorsal and anal lobe notably prolonged, the length increasing with growth. Scutes obsolescent. Body, except antedorsal area, altogether scaled. All 8 dorsal spines persisting in largest specimens examined: only second and third dorsal spines filamentous in young, very long, about 3 times the standard length. Ventral in young much prolonged, about equalling standard length ..... *Selene vomer* (p. 112)

1b. Maxillary not protractile. Scales acicular, narrow and long. Most dorsal and anal rays characteristically modified, in form of finlets partly attached ..... *Oligoplites saurus* (p. 115)

SERIOLA Cuvier

Seriola Cuvier, Regne Animal, t. 4, p. 315, 1817 (genotype *Caranx dumerili* Risso by monotypy)

Spindle shaped, depth moderate to slender. Caudal peduncle rather deep (for a carangid) to slender, compressed to depressed, with a median lengthwise keel very slightly or well developed (in small specimens the peduncle compressed, without a keel); with a somewhat crescentic pit on its dorsal and ventral aspect, near caudal base. Snout moderately long, obtuse. Adipose eyelid moderately developed posteriorly, slightly so anteriorly. Maxillary ending under anterior margin of pupil or middle of eye, notably broadening posteriorly; supplemental maxillary well developed. Mouth of medium extent, terminal, lower jaw slightly or hardly projecting. Teeth subequal, in moderately broad bands in jaws and on palatines; those on vomer in an anchor-shaped patch, backward prolongation on shaft moderate; band on tongue of medium width. Anus near normal position of first anal spine. Scales small; antedorsal area scaled to a vertical between eye and preopercular margin; cheek and upper part of opercle scaled, greater part of opercle and rest of head scaleless; caudal scaled, other fins scaleless. Anterior curve of lateral line long and low, merging very gradually with posterior straight parts; without scutes; accessory l.l. very short, extending backward for a very short distance only. First dorsal reduced, low with 7–8 spines (number of spines differing with the species and intraspecifically with growth and with the individual, see below); the anterior spines connected by membrane, rather flexible or moderately pungent; the last two spines partly disconnected, short but stout and pungent (relatively longer, slenderer and connected by membrane in the young). Second dorsal with a relatively short, unsegmented, flexible ray in front (probably a spine homologically), and 28–40 segmented rays. Anal similar in structure to second dorsal, with 19–22 segmented rays; preceded by two short, pungent spines, disconnected from rest of fin (the first spine disappearing in the larger specimens of *zonata* and probably also in those of *falcata*). Dorsal and anal lobe well developed or moderate, depending on the species; fold at dorsal and anal base very moderate; dorsal having 7–19 rays more than anal. Ventral rather long, extending more than half the distance from its base to soft anal origin; its outer angle below or slightly in front of lower pectoral angle. Pectoral short, ending in front of a vertical through end of ventral. Caudal subequal to or a little shorter than head.

The preserved, larger specimens of three species here treated are usually of a yellowish golden color, often dusky, with some blackish shades on dorsal, anal and ventral, without specific markings. The smaller specimens have the body with a transversely banded color pattern, and another oblique band in the nuchal region. The size at which the banded pattern disappears differs with the species.

The current systematics of the western Atlantic amberjacks is in a very unsatisfactory state. Jordan (1884, p. 123) gives a key to 7 species of *Seriola* which are said to occur on the east coast of the United States. This treatment is continued by Jordan and Evermann (1896, pp. 901–905) and by Jordan, Evermann and Clark (1930, pp. 279–280). However, based on the evidence hitherto presented and that determined by me not more than 4 species are now definitely known from eastern United States. Hildebrand and Schroeder (1928, p. 218) ascribe only one species to Chesapeake Bay, which they designate *S. dumerili.* They also state that *zonata* and *lalandi* are identical with *dumerili* in the synonymy of which they place those two names. However, this study has shown that *dumerili* and *zonata* constitute two quite distinct species; while the status of *lalandi* must remain uncertain until its type specimen is reexamined in the light of the evidence here presented, but based on its original description the name *lalandi* is likely synonymous with *zonata.* The three specimens which I examined from Chesapeake Bay belong to *zonata* (see its account) rather than to *dumerili,* although it is quite likely that the latter species also occurs in the Bay.

During this investigation, I made a detailed study of all the western Atlantic specimens of *Seriola* available to me which, in the aggregate, constitute a fair composite sample, comprising 89 specimens 97–945 mm. in 64 constituent samples, and 33 specimens 15–86 mm. in 20 constituent samples. One specimen each was taken in the Yucatan Channel, Bermuda, Haiti and Panama, two in Puerto Rico and 3 each in Cuba and in the Bahamas; all others came from eastern United States.

The 89 larger specimens are fairly, though not sharply, divisible into three species which are here named *falcata, dumerili* and *zonata.* The three species are fairly distinguishable when the fish reach a length of 300 mm. or so. Specimens about 150–250 mm. are more difficult to distinguish because some of the trenchant specific characters, namely, the shape of the body, caudal peduncle and dorsal and anal fins are as yet undeveloped or not fully developed.

Still smaller specimens, those under 100 mm., are again somewhat easier to distinguish, because of specific differences in the juvenile color pattern, which disappear with growth. The group of 33 small specimens noted above are thus fairly, but not sharply, divisible into 4 species. Four of these specimens 25–60 mm. are definitely referable to *zonata,* as the graded size range examined from these to the larger specimens, is adequate to be certain of their identification. Two specimens 59–70 mm., and 22 specimens 15–69 mm., are here referred to *dumerili* and *falcata,* respectively, with some shade of reservation, as no adequate size range showing the changes from the juvenile to the larger specimens, is available to be altogether certain of their identification. The other 5 specimens 37–86 mm. are here referred to *fasciata,* as they fairly agree with Bloch's figure of his species. All these small specimens are described under the species to which they are tentatively or definitely referred. The characters of those tentatively referred to *dumerili* and *falcata* are given separately in all the accompanying tables, including those giving the frequency distribution of the fin ray counts.

Considering the size and make-up of the composite sample examined it would seem that four and not more than four species of *Seriola* exist on the east coast of the United States anyway. In fact, if more than four species exist in the western Atlantic, better evidence than that hitherto presented will have to be forthcoming to prove it. Of the seven species, recognized by Jordan and his co-workers, as cited above, the names

carolinensis and *lalandi* are apparently synonyms of *zonata*, while *rivoliana* and *falcata* probably represent corresponding eastern and western Atlantic populations, respectively, as discussed below under the latter.

The number of gill rakers is of considerable value in properly distinguishing the species of *Seriola;* but in using this character it is important to take into consideration its change of growth. In *falcata* the growth change is apparently so small as to be virtually negligible, perhaps one gill raker disappearing with growth occasionally; but in *dumerili* and *zonata* it is considerable. As the fish grows in the latter two species, some of the gill rakers at both ends of the gill arch assume a recumbent position flat against the arch and become reduced to assume the form of low tubercles having a granular surface. Furthermore, with growth similar supernumerary tubercles appear between the gill rakers and between the tubercles representing original gill rakers. Also, the primary and supernumerary tubercles often partly coalesce with one another. The net result is that in the larger specimens of *dumerili* and *zonata* the number of primary tubercles which represent the original terminal gill rakers, is not definitely determinable. As a further consequence, in comparing the number of fairly or well defined gill rakers in the larger specimens of *dumerili* and *zonata* with similar specimens of *falcata*, the divergence is considerable; while in a like comparison of small specimens the extent of divergence between the species is much reduced.

The number of specimens of *dumerili* and *zonata* entered in table 1 is much less than the number examined, because the total number of gill rakers, including primary tubercles, on the first gill arch is not definitely determinable in most specimens examined.

TABLE I

Frequency distribution of the total number of gill rakers, including 1–3 determinable tubercles at ends of arch in four western Atlantic species of *Seriola.*

species and length in mm.	distribution 21	22	23	24	25	26	27	28
falcata 164–800	....	....	....	....	2	4	4	....
falcata 37– 69	....	....	....	....	....	4	7	2
fasciata 37– 86	....	....	....	....	3	1	....	1
dumerili 181	....	....	....	1	....	....	....	....
dumerili 59– 70	....	1	....	1	....	....	....	....
zonata 153–243	7	9	7	....	2	....	....	....
zonata 41–139	4	5	2	....	....	....	....	....

The number of spines in the first dorsal of *Seriola* is of some value as a species character. It appears to be subject to a moderate degree of individual variability, or to change with growth, depending on the species. In *zonata* 49 specimens 25–620 mm. have 8 spines, and 6 specimens 125–258 mm. have 7 spines (the fin damaged in 6 specimens). In the 8-spined specimens the relative length and thickness of the spines are as follows: the first three spines graduated, the first very low, the third moderately shorter than fourth; the fourth and fifth subequal and longest, stouter than anterior three; the sixth moderately shorter than fifth; the last two short and stout. In *dumerili,* 21 specimens 70–394 .mm., have 7 spines, and considering the relative size of the several spines as compared with the 8-spined specimens of *zonata* it is evident that it is the first spine that is missing in *dumerili.* In *falcata* the number seems to differ with growth, the first spine disappearing very early in life, as two specimens 14–15 mm.,

tentatively identified as *falcata*, have 8 spines, while 30 other specimens 15–800 mm. have 7 spines. In *falcata* also it is apparent that the first spine is the one that disappears. On the other hand, differences in the number of spines of *zonata* appear to be a matter of individual variability. The presence of only 7 spines in the 6 variants of *zonata*, as stated above, evidently is not a growth change. It is not due to the disappearance of the first spine. In two specimens it seems as though the last spine is missing. In the other variants the relative length and thickness of the several spines are somewhat different than in the 8-spined specimens. It is evident that these 6 specimens are individual variants with respect to the structure of the first dorsal; they had only 7 spines to begin with. Finally, five small specimens of *fasciata*, 37–86 mm. have 8 spines, their number and relative sizes being as in most specimens of *zonata*. In sum, it is evident that subject to two limiting factors, individual variability and growth change, the number of spines in the first dorsal is of some value in distinguishing the species.

The species of *Seriola* differ in the size or number of scales. However, in practice it is well nigh impossible to apply this character with any degree of precision, because the scales are small and rather irregularly arranged. For this reason, while the range of the scale counts is given under the accounts of the 4 species and in the key, not much dependence is here placed on these numbers for distinguishing the species; but they are of some limited value in placing specimens near the borderline with respect to other characters. The given counts refer to the number of oblique rows over the lateral line, from its beginning to the caudal base. The range of the scale count given under every species is based on 10 specimens, except 4 specimens in *fasciata*.

The term "preanal" used in the following accounts of the species and in table 2 refers to the distance from the tip of the lower jaw to the base of the first free anal spine or its approximate position when it has disappeared with growth, as in the larger specimens of *zonata*. The height of the dorsal and anal lobes was measured from the base of the flexible spine to the tip of the highest ray, that is, the second or third segmented ray. The height and width of the caudal peduncle was measured at a point just in front of the pit.

TABLE II

Frequency distribution of the preanal distance in four western Atlantic species of *Seriola*, expressed as a percentage of the standard length, segregated by size groups.

species	standard length in mm.	distribution 58	59	60	61	62	63	64	65	66	67	68	69	70	71
falcata	280–408	....	1	4	2	1	....	....	....	....	....	....	....	....	....
dumerili	266–318	....	....	1	1	2	1	....	....	....	....	....	....	....	....
zonata	300–370	....	....	....	....	....	....	....	....	....	1	4	5	3	....
falcata	132–202	1	....	....	1	....	....	....	....	....	....	....	....	....	....
dumerili	148–254	....	....	....	1	6	3	2	2	....	....	....	....	....	....
zonata	149–248	....	....	....	....	....	....	....	....	1	5	4	3	5	1
zonata	81–147	....	....	....	....	....	....	....	1	4	4	9	4	1	....
falcata	29– 56	....	....	....	1	1	1	2	1	2	1	3	1	....	....
fasciata	29– 69	....	....	....	....	....	2	....	2	....	1	....	....	....	....
dumerili	47– 56	....	....	....	....	....	....	....	....	....	....	....	1	....	1
zonata	20– 50	....	....	....	....	....	....	....	....	....	....	1	1	1	1

As the species of *Seriola* change markedly with growth, specimens have to be compared size for size in order to distinguish the species properly. The following accounts

are based almost exclusively on specimens 500 mm. or smaller, and will most probably not apply altogether to very large specimens. One specimen 945 mm. for which no comparative material is available, is treated separately under the account of *dumerili*. Two skinned specimens about 565 and 880 mm. long, belonging to *dumerili* and *falcata*, respectively, are included in their accounts. As no proportional measurements could be determined for the latter two specimens, they were identified by their counts and general appearance.

TABLE III

Frequency distribution of the height of the soft dorsal lobe in four western Atlantic species of *Seriola*, expressed as a percentage of the standard length.

species	standard length in mm.	distribution 13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
falcata	280–408	....	....	....	....	....	....	....	....	....	2	1	1	2	1	....	1
dumerili	266–318	....	2	1	2	....	....	....	....	....	....	....	....	....	....	....	....
zonata	300–370	....	2	6	5	...	....	....	....	....	....	....	....	....	....	....	....
falcata	132	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....
dumerili	148–254	1	1	6	6	...	....	....	....	....	....	....	....	....	....	....	....
zonata	149–248	....	....	5	4	7	2	....	....	....	....	....	....	....	....	....	....
zonata	81–147	....	....	....	5	7	7	4	....	....	....	....	....	....	....	....	....
falcata	29– 56	....	....	....	....	....	2	2	3	3	2	....	....	....	....	....	....
fasciata	29– 69	....	....	....	....	....	1	3	....	....	....	....	....	....	....	....	....
dumerili	47– 56	....	....	....	....	....	....	....	2	....	....	....	....	....	....	....	....
zonata	20– 50	....	....	....	....	....	1	....	3	....	....	....	....	....	....	....	....

Under the following accounts of the species, I have attempted to give some of the more important references, especially references to synonyms. The segregation of these references by species has been made on the basis of the published accounts, except in three instances where the specimens on which the records are based have been re-examined. The synonymies here given are of a highly tentative nature for two reasons. First, published descriptions, in general, are inadequate and it is uncertain as to what species a given author had before him. The species are very close in their structural characters, and current descriptions either omit or do not give the pertinent specific characters in sufficient detail to identify the particular species with certainty. Besides, growth changes within the species are pronounced, and until such changes are better known the status of species based on small specimens must remain in doubt. Second, the synonymies here given are based on the assumption that only four species of the genus exist in the western Atlantic, which as yet cannot be regarded as definitely established. Ordinarily, it would not seem advisable to try to establish synonymies on the basis of such inadequate data. However, in this instance it is thought that these tentative synonymies will be of some help in the further study of the western Atlantic species of *Seriola*. If it is eventually proved that more than 4 species occur in the western Atlantic, some of the names here placed in synonymy will likely have to be resurrected. Also, it is very possible that the given synonymies will have to be rearranged after an examination of such specimens as are still in existence, on which the published records are based.

Seriola is very close to *Naucrates* Rafinesque which differs primarily in having the first dorsal still further reduced. *Naucrates ductor* has the caudal peduncle depressed as in *Seriola zonata*. The body is slenderer on the average and the keel on the caudal peduncle somewhat better developed than in *S. zonata;* while the dorsal and anal rays

average less than in *S. falcata*. *Seriola* differs from *Elagatis* in lacking a separate finlet behind the dorsal and anal. Otherwise, these three genera are readily distinguished from the other carangids here treated by the combination of characters given in the key.

TABLE IV

Frequency distribution of the height of the anal lobe in three western Atlantic species of *Seriola*, expressed as a percentage of the standard length.

species	standard length in mm.	distribution 10	11	12	13	14	15	16	17	18	19	20
falcata	280–408	....	....	....	....	....	....	....	....	4	3	1
dumerili	266–318	....	....	1	2	2	....	....	....	....	....	....
zonata	300–370	1	3	6	3	....	....	....	....	....	....	....
falcata	132–202	....	....	....	....	....	1	....	1	....	....	....
dumerili	148–254	....	....	2	10	1	1	....	....	....	....	....
zonata	149–248	....	....	9	8	2	....	....	....	....	....	....
zonata	81–147	....	....	7	14	2	....	....	....	....	....	....

Seriola falcata Cuvier and Valenciennes

Falcate amberjack, Plate 1, fig. a; Plate 2, figs. a and c

Seriola falcata Cuvier and Valenciennes, Hist. Nat. Poiss. 9:210, 1833 (Gulf of Mexico).—Jordan and Gilbert, Proc. U. S. Nat. Mus. 5:271, 1882 ("Snapper Bank at Pensacola").—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 905, 1896 ("West Indies, north to Florida and Carolina")

Seriola boscii Cuvier and Valenciennes, Hist. Nat. Poiss. 9:209, 1833 (Carolina; based on small specimen)

Seriola bonariensis Cuvier and Valenciennes, ibid., p. 211, 1833 (Buenos Aires).—Goode and Bean, Proc. U. S. Nat. Mus. 2:48, 1879 (Pensacola; reexamined)

Seriola declivis Poey, Mem. Hist. Nat. Cuba 2:230, 1860 (Cuba)

Seriola ligulata Poey, ibid., p. 231 (Cuba)

Seriola coronata Poey, ibid., p. 232 (Cuba)

D VII (VIII); I 28–32. A (I) II; I 19–22. P. 19–22. GR 7–8+16–18. Sc 122–137.

TABLE V

Frequency distribution of body depth measured at origin of soft dorsal in four western Atlantic species of *Seriola*, expressed as a percentage of the standard length.

species	standard length in mm.	distribution 24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
falcata	280–408	....	....	....	....	....	....	....	....	....	....	....	2	3	1	1	....	1	....	....
dumerili	266–318	....	....	....	....	....	....	....	....	1	1	....	3	....	....	....	....	....	....	....
zonata	300–370	2	1	....	2	3	4	1	....	....	....	....	....	....	....	....	....	....	....	....
falcata	132–202	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	....	....
dumerili	148–254	....	....	....	....	....	....	1	3	2	1	5	1	....	1	....	....	....	....	....
zonata	149–248	....	....	....	....	....	....	2	3	3	6	5	1	1	....	....	....	....	....	....
zonata	81–147	....	....	....	....	....	....	2	2	2	5	8	3	1	....	....	....	....	....	....
falcata	29– 56	....	....	....	....	....	....	....	....	....	....	....	....	1	...	6	2	1	3	....
fasciata	29– 69	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	1	1	....	1
dumerili	56	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....
zonata	20– 50	....	....	....	....	....	....	....	....	1	1	2	....	....	....	....	....	....	....	....

Anal fin not placed notably backward, preanal 59.5–62.0; dorsal and anal lobes comparatively high, 21.5–27.5 and 18–20, respectively; body deep (for a *Seriola*), 34.5–40.0; caudal peduncle compressed, the keel very moderate or hardly perceptible; depth at posterior margin of head subequal to its length or slightly more, head 29.0–30.5, depth at its posterior margin 29.0–32.5. Gill rakers on upper limb 7–8, on lower limb 16–18, usually with one tubercle-like outgrowth at anterior end, sometimes 2 or 3 tubercles; total number of gill rakers and tubercles on both limbs 25–28. Dorsal spines 7 (in 11 specimens 164–800 mm.; dorsal spines 8 in very small specimens and gill raker count nearly the same in large and small specimens, see below). First disconnected anal spine present (absent in one large specimen, see below). Without dark bands.

TABLE VI

Frequency distribution of the depth at posterior margin of opercle in four western Atlantic species of *Seriola*, expressed as a percentage of the standard length.

species	standard length in mm.	distribution 23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
falcata	280–408	....	....	....	....	....	....	3	1	2	2	....	....	....	....	....	....	....	....	....
dumerili	266–318	....	....	....	....	....	1	2	1	1	....	....	....	....	....	....	....	....	....	....
zonata	300–370	3	1	3	5	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....
falcata	132–202	....	....	....	....	....	....	....	....	....	....	1	....	1	....	....	....	....	....	....
dumerili	148–254	....	....	....	1	1	1	2	6	1	2	....	....	....	....	....	....	....	....	....
zonata	149–248	....	....	1	2	1	3	6	4	1	1	....	....	....	....	....	....	....	....	....
zonata	81–147	....	....	....	....	1	2	7	5	6	2	....	....	....	....	....	....	....	....	....
falcata	29– 56	....	....	....	....	....	....	....	....	....	....	....	....	....	2	3	6	....	1	1
fasciata	29– 69	....	....	....	....	....	....	....	....	....	....	....	....	2	....	1	1	....	1	....
dumerili	56	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	....	....	....
zonata	20– 50	....	....	....	....	....	....	....	....	....	....	2	1	1	....	....	....	....	....	....

The above description is based on 8 specimens 350–500 mm. Two specimens 164–245 mm. nearly agree, except in having a wide, oblique, black band running from eye to origin of first dorsal. Their measurements are given separately in tables 1–6. One skinned specimen, about 880 mm., nearly agrees with the above description in its determinable characters, except that the first anal spine is absent at the surface.

Twenty-two specimens examined, 15–69 mm., are tentatively referred to this species, as no graded size range to the larger specimens is available to make this identification altogether certain. Their fin ray counts are given separately in tables 8–9. Two specimens 15–16 mm., have 8 spines in the first dorsal; the other 20 specimens 15–69 mm., have 7 spines. All have the two anterior anal spines well developed. The measurements of 13 specimens 36–69 mm. are given separately in tables 2–3 and 5–6. The gill rakers are rather well developed, and number in the latter 13 specimens 7–9+18–20, except that one specimen has a tubercle at the end of the lower limb in addition to 18 well developed gill rakers; total number on both limbs 26–28, including the tubercle. Six specimens 15–21 mm. have no bands, one specimen 23 mm. has faint bands, while the other 15 specimens 31–69 mm., have dark bands, as follows: an oblique band on nape running from posterior margin of eye to origin of first dorsal; body with cross bands, usually 5 bands, the first directly behind head narrower than others, the fifth a little in front of end of dorsal and anal fins; sometimes with six bands on one or both sides, the sixth band at end of dorsal and anal fins; occasionally a faint trace of a band at caudal base. The body bands are not solidly colored, a lighter narrow, irregular area running transversely along their middle.

Specimens examined from or off the following localities: Georgetown, S. C., (151949). Fla. (26591). Clearwater, Fla. Pensacola, Fla. (22901). Mississippi Delta, La. Bermuda (21391). Watling Island, Bahamas (38423). Cuba (12539). Port au Prince, Haiti (133682). Colon, Panama (148913). Altogether 10 specimens 164–500 mm. Also, one skinned specimen about 800 mm. from Pensacola, Fla. (22258). Localities for the 22 small specimens tentatively referred to this species, as described above: eastern United States (106279). Cape Charles, Va. (131934). Cape Hatteras (83771) and Beaufort (105863, 106152–3, 106278, 106420), N. C. Tortugas, Fla. (88092). Puerto Rico (117871).

TABLE VII

Frequency distribution of the ratio of the depth of the caudal peduncle divided by its width at the same point, just in front of the pit, in three western Atlantic species of *Seriola*.

species	standard length in mm.	distribution 0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7
falcata	280–408	....	....	....	....	....	....	2	2	3	1	....
dumerili	266–318	....	....	....	2	1	1	1	....	....	....	....
zonata	300–370	1	4	5	3	....	....	....	....	....	....	....
falcata	132–202	....	....	....	....	....	....	....	1	....	....	1
dumerili	148–254	....	....	....	1	4	1	2	4	2	....	....
zonata	149–248	....	2	4	7	6	1	....	1	....	....	....
zonata	81–147	....	....	1	7	8	5	1	....	1	....	....

The larger specimens of *falcata* differ from both *dumerili* and *zonata* in having the dorsal and anal lobes markedly higher. They further differ from similar specimens of *zonata* in having a shorter preanal distance, a deeper body and a compressed caudal peduncle.

TABLE VIII

Frequency distribution of the number of segmented dorsal rays in four species of *Seriola*.

species and length in mm.	distribution 28	29	30	31	32	33	34	35	36	37	38	39	40
falcata 164–880	3	2	6	....	....	....	....	....	....	....	....	....	....
falcata 15– 69	4	3	4	7	4	....	....	....	....	....	....	....	....
fasciata 37– 86	....	....	1	1	2	....	....	....	....	....	....	....	....
dumerili 181–394	....	....	2	3	6	6	2	2	....	....	....	....	....
dumerili 59– 70	....	....	....	1	1	....	....	....	....	....	....	....	....
zonata 41–514	....	....	....	....	....	1	7	10	21	11	7	2	1

The gill rakers in the larger specimens of *falcata* number 7–8+16–18; while the number of well defined gill rakers in similar specimens of *dumerili* and *zonata* is 2–3+11–13. This difference is also one of development. Both *dumerili* and *zonata* have an increased number of gill rakers in the smaller specimens. With growth some of the gill rakers, at both ends of the gill arch, become so reduced and coalesced with the arch and with one another that their number is not definitely determinable, as discussed under the genus. In *falcata*, on the other hand, this growth change is slight, and as a consequence the larger specimens are rather well separable from *dumerili* and *zonata* on the basis of the gill raker count. In small specimens the gill raker count of *falcata* does not diverge as widely from the other two species.

This species averages the lowest dorsal count. It does not intergrade with *zonata* in this character, but it does so with *dumerili*. Its scale count is also low as compared with the other two species; but the latter character is difficult to apply in practice, as the scale count is not determinable with a high degree of precision.

TABLE IX

Frequency distribution of the number of segmented anal rays and the number of pectoral rays in four western Atlantic species of *Seriola*.

species and length in mm.	anal rays 19	20	21	22	pectoral rays 16	17	18	19	20	21	22
falcata 164–880	2	1	8	....	....	....	....	....	2	6	3
falcata 15– 69	2	8	11	1	....	....	....	1	3	9	2
fasciata 33– 86	2	1	....	....	....	....	....	1	4	....	....
dumerili 181–394	2	10	7	2	....	....	....	1	3	16	1
dumerili 47– 56	....	2	....	....	....	....	....	....	1	1	....
zonata 25–514	16	33	11	....	1	....	3	18	32	7	....

Nomenclature.—A specimen from the Azores (94489), presumably an example of *rivoliana*, 236 mm. in standard length, measures the dorsal and anal lobes 19.0 and 16.5, while in 9 specimens from the western Atlantic 202–408 mm., the same two measurements are 20.5–27.5 and 17.5–20.0, respectively. The well marked lobes in the western Atlantic specimens as compared with the one from the eastern Atlantic, are more striking in appearance than the measurements would indicate. It is also possible that *rivoliana* averages a shorter ventral than *falcata*, as the ventral length in the above one and nine specimens is 18.5 and 18.5–20.5, respectively. While the samples compared are inadequate to draw definite conclusions, it is probable that these corresponding eastern and western Atlantic populations diverge sufficiently to constitute distinct species or subspecies. Therefore, I apply the name *falcata* which is based on specimens from the Gulf of Mexico, to the western Atlantic population.

Seriola fasciata (Bloch)

Little amberjack, Figure 1; Plate 2, fig. e

Scomber fasciatus Bloch, Ichthyologie ou Histoire Naturelle des Poissons pt. 10, p. 61, pl. 341, 1797 (locality unknown)

Seriola semicoronata Poey, Mem. Hist. Nat. Cuba 2:232, 1860 (Cuba)

D VIII; I 30–32. A II; I 19–20. P 19–20. GR 7–8+18–20. Sc. 129–134.

The following description of this species is not strictly comparable with those of the other 3 species, as it is based on small specimens only, 37–86 mm., while the specific characters of the species of *Seriola* change markedly with growth. Its comparison with the small specimens of the other species is best made in the accompanying tables.

Anal fin not placed notably backward, preanal 62.5–67.5; dorsal lobe 18.0–19.5; anal lobe 14.5–16.5; depth 37–42; caudal peduncle compressed, without a keel (same holds for small specimens of other 3 species); depth at posterior margin of head greater than its length or subequal to it, head 33.0–37.5, depth at its posterior margin 35–40. Gill rakers rather well developed 7–8+18–20, or 25–28 in total count. Dorsal spines 8. Both anterior anal spines well developed. Body typically with 8 cross bands, the seventh at end of dorsal and anal fins, the eighth on caudal peduncle; most bands

usually well divided by a transverse median irregular lighter area; sometimes the lighter area very wide, leaving only the narrow margins of the bands, such variants having appearance of a cross-streaked pattern with the streaks arranged roughly in pairs; nuchal band solidly pigmented, moderately oblique, extending from eye upward and somewhat backward, not quite reaching origin of first dorsal.

Specimens examined from off the following localities: Long Island, N.Y. (35573). Cape Charles, Va. (157569). Beaufort, N.C. (105862). Tortugas, Fla. (116868). One specimen taken by the Fish Hawk, without data, evidently collected in the western Atlantic and most likely on the coast of the United States. Total examined 5 specimens 37–86 mm.

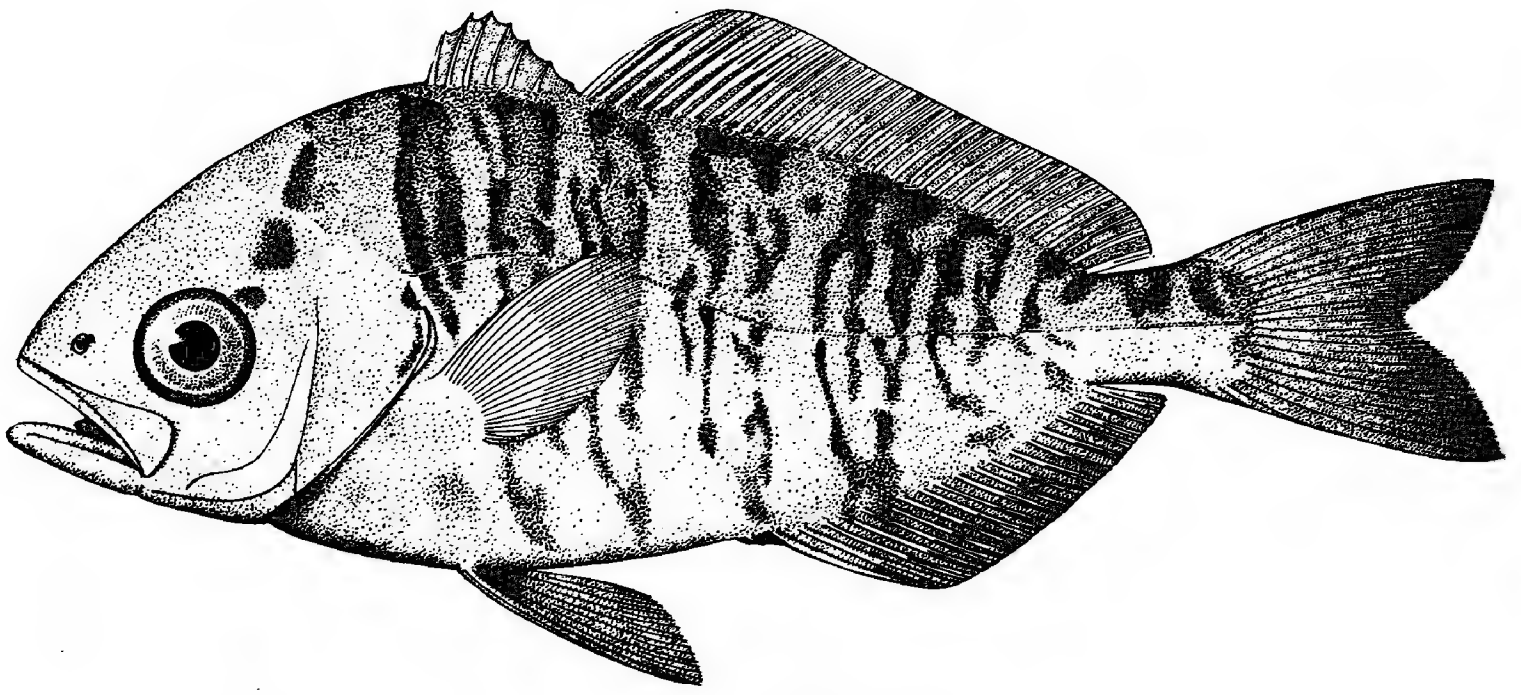

FIGURE 1

Seriola fasciata, 46.6 mm in standard length, about 58 mm long. Albatross Station 2047, lat. 40° 02′ 30″ N, long. 68° 49′ 40″, off Long Island, N. Y., at the surface. USNM 33573.

The 5 small specimens examined of this species fairly agree in their counts and measurements with 22 similar specimens of *falcata,* except in having 8 dorsal spines, instead of 7, and in the color pattern. The nuchal band is not as oblique as in *falcata,* the body bands are more numerous, and the median lighter area within the bands is usually wider. This species differs from *dumerili* and *zonata* in having more gill rakers. It is possibly a small species. A larger example of this species was not found among the many specimens examined. Bloch does not give the size of his specimens, but the *semicoronata* of Poey which seems to be a synonym of *fasciata,* is based on a specimen 240 mm.

Nomenclature.—Bloch's figure of his *fasciata* shows a moderately oblique nuchal band, and the body bands split transversely in an irregular manner. Allowing for individual variability and the rather crude nature of the illustrations published by Bloch and his contemporaries, his figure seems to have been made from a specimen of the same species as the 5 specimens described above, and the name *fasciata* is, therefore, applied to these specimens.

Seriola dumerili (Risso)

Great amberjack, Plate 1, fig. b

Caranx dumerili Risso, Ichthyologie de Nice, p. 175, pl. 6, fig. 20, 1810 (Mediterranean)

Seriola dumerili Cuvier and Valenciennes, Hist. Nat. Poiss. 9:201, 1833 (Mediterranean).—Jordan, Proc. U. S. Nat. Mus. 7:122, 1884 (Key West).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1):903, 1896 ("Mediterranean to West Indies, north to Key West and Pensacola").—Gunter and Knapp, Texas Jour. Sci. 3(1): 136, 1951 (Port Aransas, Texas)

Seriola gigas Poey, Mem. Hist. Nat. Cuba 2:227, 1860 (Cuba)

Seriola proxima Poey, ibid. p. 229 (Cuba)

Seriola lalandi Jordan and Gilbert, Proc. U. S. Nat. Mus. 5:271, 1882 (Pensacola)

Seriola zonata Jordan and Evermann (in part), Bull. U. S. Nat. Mus. no. 47(4), pl. 139, fig. 381, 1900 (specimen forming basis of figure reexamined, belonging to this species)

D VII; I 30–35. A II; I 19–22. P 19–22. GR 2–3+11–13. Sc. 141–163.

Anal fin not placed notably backward, preanal 60–63; dorsal and anal lobes moderate, 14–16 and 12.5–13.5, respectively; body moderately deep 32–35; caudal peduncle compressed to subterete, the keel moderate or very slight; depth at posterior margin of head subequal to its length, varying slightly both ways, head 29.5–30.0, depth at its posterior margin 28.5–31.0. Well developed gill rakers 2–3+11–13. Dorsal spines 7 and first disconnected anal spine present (in 21 specimens examined 70–394 mm.).

The above description is based on 5 specimens 327–394 mm. which are approximately comparable with the larger specimens described of *falcata* and *zonata*. Fourteen specimens 181–320 mm. show slight or moderate differences in proportional measurements as compared with the larger specimens, as shown in tables 2–7.

One large specimen, 945 mm., from Woods Hole (44167), has the following counts and measurements: D VI; I 33. A II; I 20. P 21. GR 2+11. Scales 160. Standard length 790 mm. Preanal 62, depth at soft dorsal origin 25, depth at opercular margin 24, dorsal lobe 13, anal lobe 13, width in depth of caudal peduncle 1.1 times. The last dorsal spine has disappeared and the first of the two detached anal spines is barely appreciable at the surface. In the preanal distance and the shape of the caudal peduncle, this specimen agrees with *dumerili*. Its dorsal and pectoral counts fall at the mode of *dumerili*, and at the extremes of the distributions of *zonata*. In its depth measurements it agrees with specimens of *zonata* 300–370 mm., as shown in tables 5–6. Also, the keel on the caudal peduncle is fairly developed as in the above specimens of *zonata*. As the latter characters change with growth in the species of *Seriola*, and in other carangid species as well the best conclusion that we may come to now, in the absence of comparative specimens of similar size, is that this large specimen is an example of *dumerili*. That is, in *dumerili*, as in *zonata*, the relative depth decreases and the peduncular keel becomes more prominent in large specimens. The fin ray counts of this specimen are included in the accompanying tables, but not its measurements.

Two specimens 59–70 mm. are tentatively referred to *dumerili*, as no adequately graded size range is available to be altogether certain of their identification. Their counts and measurements are given separately in the tables. The gill raker count in

the two specimens is 7+15–17, including one tubercle at one or both ends of the gill arch.

One specimen 181 mm. has the gill raker count 6+18 including 4 tubercles at the anterior end of the arch. This is the specimen entered in table 1. In the other specimens 209 mm. or longer, the number of primary tubercles at one or both ends of the gill arch is not definitely determinable as discussed under the account of the genus.

Specimens examined taken at or off the following localities: Acushnet River (82251) and Woods Hole (18720, 44944, 50580, 77797, 104999 and 125698), Mass. Wickford, R.I. (38114). Brooklyn, N.Y. (4608). Ocean City, Md. (76692). Pensacola, Fla. (22902). Bahamas (4653 and 53119). Cuba (82415). Venice (28450) and Bay of Naples (48319), Italy. Altogether 19 specimens 181–394 mm. Also, one skinned specimen about 565 mm. from Havana, Cuba (35064), agrees in its counts (D VII; I 34. A II; I 21. P 21; included in the tables), and general appearance with *dumerili.* Localities for the 2 small specimens tentatively referred to this species, as discussed above, are: Yucatan Channel (142886; 59 mm.; in bad condition having been dried at some time in past, some measurements not accurately determinable and no trace of color pattern left; first dorsal damaged or abnormal). Puerto Rico (108415; 70 mm.; color apparently nearly all faded, with only slight traces of cross bands).

In the number of dorsal rays and scales and the body depth of the larger specimens, *dumerili* is rather intermediate between *falcata* and *zonata,* intergrading with both in the dorsal ray count, and possibly also in the other two characters. It nearly agrees with *zonata,* and differs from *falcata* in the comparatively low dorsal and anal lobes. It nearly agrees with *falcata* and differs from *zonata* in the relatively shorter preanal distance. In the larger specimens the number of well defined gill rakers nearly agrees with *zonata,* and differs considerably from *falcata.*

Seriola zonata (Mitchill)

Slender amberjack; banded rudderfish (young), Plate 1, fig. c; Plate 2, figs. b and d

Scomber zonatus Mitchill, Trans. Lit. Philos. Soc. New York 1:427, pl. 4, fig. 3, 1815 (New York Bay)

Seriola zonata Holbrook, Ichthyology of South Carolina, p. 73, pl. 10, fig. 1, 1855 (South Carolina).—Jordan and Evermann (in part), Bull. U. S. Nat. Mus. 47(1): 902, 1896 (Cape Cod to Cape Hatteras; the published figure executed from a specimen of *dumerili,* reexamined)

Seriola lalandi Cuvier and Valenciennes, Hist. Nat. Poiss. 9: 208, 1833 (Brazil; the statement "les côtés de la queue sont relevés en une carè prononcée," describes the typical condition of large specimens of *zonata*).—Jordan, Proc. U. S. Nat. Mus. 7: 122, 1884 (Key West).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 903, pl. 140, fig. 382, 1896 ("West Florida to Brazil"; a mounted specimen on exhibition in the National Museum, which probably formed the basis of Jordan and Evermann's figure appears to be a specimen of *zonata*)

Seriola leiarchus Cuvier and Valenciennes, l. c., p. 213 (sent from Philadelphia by LeSueur)

Seriola carolinensis Holbrook, Ichthyology of South Carolina, p. 70, pl. 10, fig. 2, 1855 (South Carolina).—Holbrook, Ichthy. S.C., ed. 2, p. 72, pl. 10, fig. 2 (plate in second edition more nearly resembling *zonata* than that in first edition)

Seriola dubia Poey, Mem. Hist. Nat. Cuba 2: 228, 1860 (Cuba)

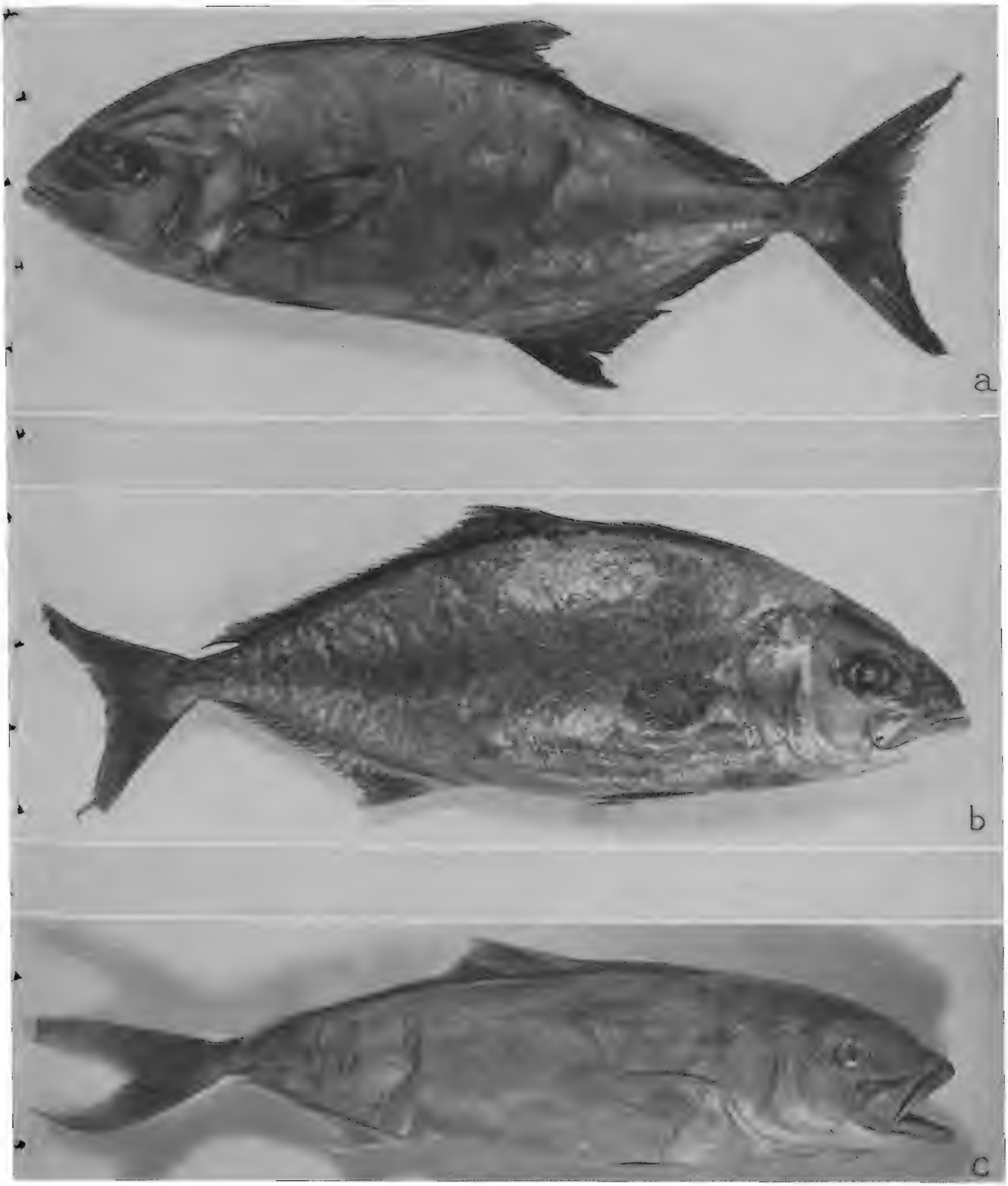

PLATE 1

Fig. a. *Seriola falcata*, 321 mm Pensacola, Fla. USNM 22901.

Fig. b. *Seriola dumerili*, 318 mm in standard length, about 390 mm long. Woods Hole, Mass. USNM 18720.

Fig. c. *Seriola zonata*, 328 mm in standard length, about 400 mm long. Charleston, S. C. USNM 4606.

Seriola stearnsi Goode and Bean, Proc. U. S. Nat. Mus. 2: 49, 1879 (Gulf of Mexico; reexamined).—Jordan and Gilbert, ibid. 5: 270, 1882 (Snapper Banks about Pensacola)

D VII–VIII; I 33–40. A I(II); I 19–21. P(16) 18–21. GR 2–3+11–13. Sc 160–187.

Anal fin placed notably backward, preanal 67.0–69.5; dorsal and anal lobes moderate, 14.0–16.5 and 10.5–13.0, respectively; body rather slender, depth 24–30; caudal peduncle usually depressed, sometimes subterete, the keel rather well developed; depth at posterior margin of head less than its length, head 29–32, depth at its posterior margin 22.5–26.5. Well developed gill rakers 2–3+11–13; rudimentary ones at both ends of arch not definitely determinable. Dorsal spines usually 8, sometimes 7 as an individual variation (see discussion under genus). First disconnected anal spine absent at the surface. Without bands.

The above description is based on 14 specimens 362–620 mm. Small specimens have a striking, banded color pattern as follows. Body with 6 cross bands, the first directly behind head, the fifth a little in front of end of dorsal and anal fins, the sixth on caudal peduncle; the bands uniformly pigmented, subequal in width to interspaces, continued on second dorsal and anal and becoming oblique in position on fins; a similar oblique band from eye to origin of first dorsal. The banded pattern is evident but not sharply marked in a specimen of 25 mm. (perhaps faded), is well marked in specimens 41 mm. up to about 220 mm., fades out and disappears between 220 and 260 mm.

Both the head length and the depth at its posterior margin are greater in the smaller specimens, but the increase in depth is relatively greater. In 11 specimens 122–199 mm. depth at posterior margin of head moderately less than, or subequal to its length, head length 30.5–34.0, depth at its posterior margin 28.5–32.0. Other changes in proportional measurements in the smaller specimens are shown in tables 2–7. Another growth change refers to the visual disappearance of the first pungent anal spine. Both detached anal spines are present in 42 specimens 25–254 mm., and 3 specimens 277–299 mm.; but the first spine is absent at the surface in 13 specimens 362–620 mm., and 3 specimens 258–296 mm.

The number of primary tubercles on the first gill arch, as discussed under the account of the genus, is countable in specimens up to about 245 mm., but sometimes not definitely determinable in specimens as small as 180 mm. The determinable specimens are entered in table 1.

Specimens examined from or off the following localities: North Truro (48909) and Woods Hole (12997, 14056, 14808, 16513, 20490, 49605, 58897, 70346, 73485 and 125668), Mass. Newport, R.I, (25712). Atlantic City (45201–2) and Seaside Park (93929), N.J. Havre de Grace (85554) and Ocean City (76696), Md. Cape Charles (42448–9), Willoughby Point (25634) and Cape Henry (16748), Va. Cape Hatteras (53118), Cape Lookout (74288–9, 74296) and Beaufort (106292), N.C. Georgetown (151944) and Charleston (4606, 24680, 25169 and 127214), S.C. Clearwater, Fla. Pensacola, Fla. (22325, type of *stearnsi*). Eastern United States (106279). Washington, D.C. market (92400). No locality (16799, one specimen). Total examined 62 specimens 25–620 mm., in 38 constitutent samples. The largest is from Pensacola.

The larger specimens of *zonata* differ from *falcata* and *dumerili* in the longer preanal distance. They nearly agree with *dumerili* and differ from *falcata* in the moderate dorsal and anal lobes and the gill raker count. As compared with the other two species, *zonata* is notable in usually having a depressed caudal peduncle, a well marked

peduncular keel, a slender body and high dorsal ray and scale counts. In the latter characters it is rather discontinuous as compared with *falcata,* but approaches to or somewhat intergrades with *dumerili.* It further differs from those two species in usually having 8, instead of 7 dorsal spines (see discussion under genus).

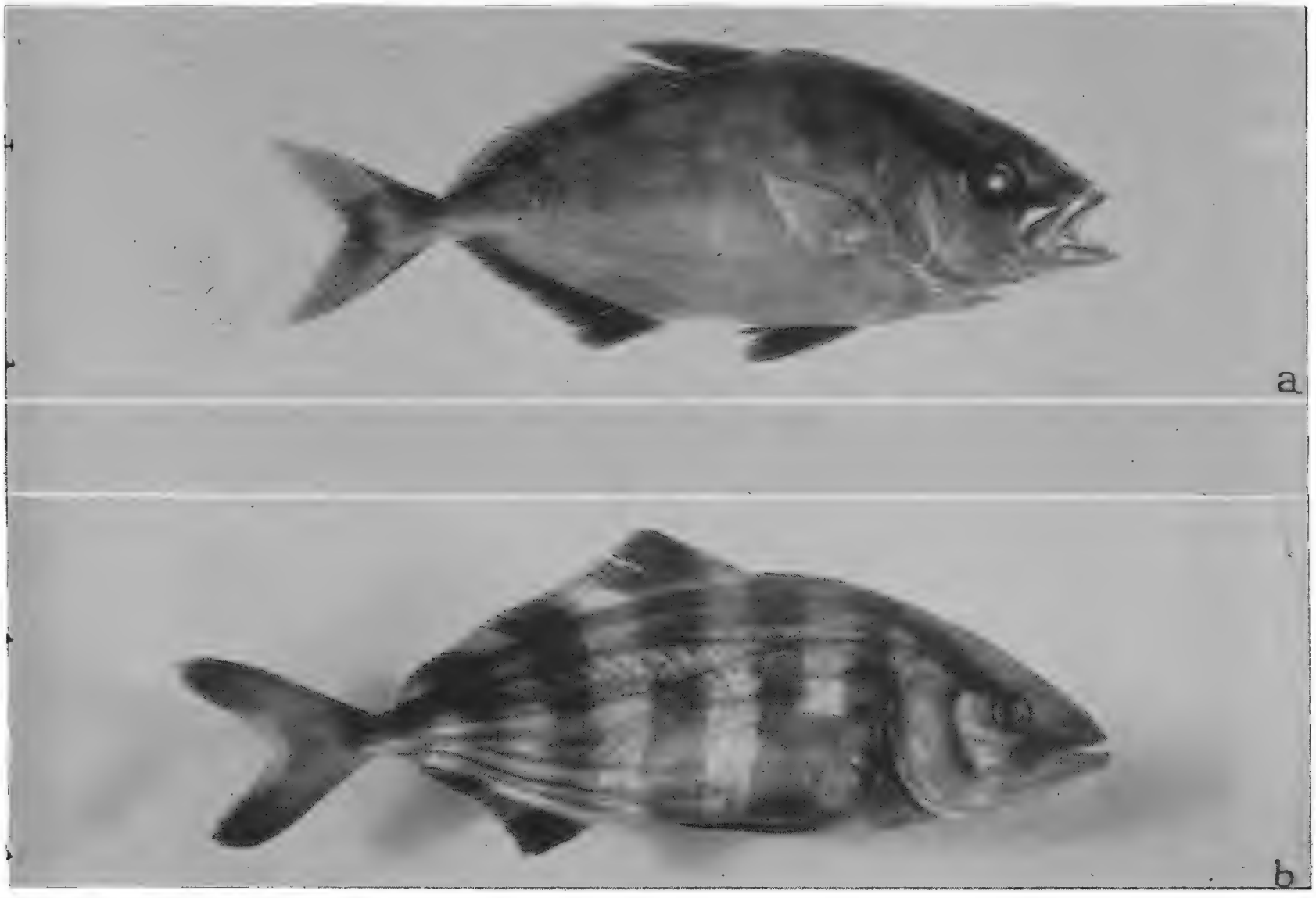

PLATE 2

Fig. a. *Seriola falcata,* 164 mm Clearwater, Fla. USNM 157564.
Fig. b. *Seriola zonata,* 179 mm Woods Hole, Mass. USNM 70346.

ELEGATIS Bennett

Elagatis Bennett, Narrative of a whaling voyage around the globe, vol. 2, p. 283, 1840 (genotype *Elagatis bipinnulatus* Bennett by monotypy).

This genus nearly agrees with *Seriola* in the characters studied, but differs in having a separate finlet behind the dorsal and anal, only 6 dorsal spines, and a notably greater number of gill rakers.

Elagatis bipinnulatus (Quoy and Gaimard)

Rainbow runner

Seriola bipinnulata Quoy and Gaimard, Voy. Uranie, p. 363, pl. 61, fig. 3, 1824 (Papua)

Elagatis bipinnulatus Bennett, Narrative of a whaling voyage round the globe, vol. 2, p. 283, fig., 1840 ("Examples came under our notice in the Pacific Ocean and Indian Archipelago, from lat. 6° N. to 8° S. They were very numerous around a log of drift-wood, on the Equator, in long. 140° E., as well as in the Straits of Timor." *E. bipinnulatus* described as a new species without reference to Quoy and Gaimard).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 906, 1896 (Long Island).—Nichols and Breder, Zoologica 9: 109, fig. 145, 1926 (New York).—Gunter and Knapp, Texas Jour. Sci. 3: 136, 1951 (off Port Aransas)

Seriolichthys bipinnulatus Gunther, Cat. Fish. Brit. Mus. 2:468, 1860 (Amboyna)

Seriola pinnulata Poey, Mem. Hist. Nat. Cuba 2: 233, 1860 (Cuba)

D VI; I 25–26; 2. A O–II; I 16–17; 2. P 20–21. GR 10–11+25–26.

PLATE 2—(Continued)

Fig. c. *Seriola falcata*, 69 mm Beaufort, N. C. USNM 106153.

Fig. d. *Seriola zonata*, 50 mm in standard length, about 60 mm long. Woods Hole, Mass. USNM 58897.

Fig. e. *Seriola fasciata*, 79 mm Collected by the Fish Hawk, apparently in the western Atlantic and very likely on the coast of the United States, precise locality unknown. USNM 157565.

Spindle shaped, slender; caudal peduncle rather wide (for a carangid), the keel but slightly indicated. Snout rather long, moderately tapering. Adipose eyelid fairly developed posteriorly, slightly so anteriorly. Maxillary ending at a considerable distance before eye (to under anterior margin of eye in small specimens); moderately broadening posteriorly; supplemental maxillary comparatively narrow. Mouth rather small, terminal, jaws subequal in front. Teeth subequal, in bands of moderate width in jaws, tapering, becoming narrow, posteriorly; in a roughly triangular, rather large patch on vomer, tapering moderately backward for a moderate distance; in a rather wide band on palatines and tongue. Anus placed near normal position of first anal spine. Scales small; scales on antedorsal area extending to a vertical between preopercular margin and eye; cheek and upper part of opercle scaled, greater part of opercle and rest of head scaleless; caudal scaled, other fins scaleless. Anterior curve in lateral line very low, continued imperceptibly into posterior straight part; scales in l.l. not scute-like; accessory l.l. extending for a short distance, falling short of a point opposite preopercular margin, marking boundary of scaled part on dorsal aspect. Spinous dorsal rather low, with 6 spines connected by membrane, last one partly so, the anterior spines rather flexible. First anal spine disappearing at the surface at about 200 mm., second also disappearing in the larger specimens. Dorsal and anal lobes rather low; fold at the base of fins moderate anteriorly, absent posteriorly; dorsal having 9 more rays than anal; behind each fin a detached finlet, spaced for some distance and having 2 rays. Ventral short, extending less than half the distance from its base to soft anal origin, its outer angle under lower pectoral angle. Pectoral short, ending in front of a vertical through end of ventral. Caudal longer than head.

TABLE X

Frequency distribution of the number of dorsal spines and rays in four species of *Trachinotus*.

species	spines*		segmented rays									
	6	7	18	19	20	21	22	23	24	25	26	27
falcatus	....	24	1	16	7	....	....	....	....	....	....	....
glaucus	....	39	....	23	16	....	....	....	....	....	....	....
marginatus	....	7	....	2	4	1	....	....	....	....	....	....
carolinus	51	295	....	....	....	....	....	36	183	110	12	1

*As the spinous and soft dorsal are continuous in young specimens, all the dorsal spines, the one which becomes with growth part of the second dorsal as well, are included in the count, the data referring to both small and large fish.

The preceding description is based on two specimens, one each from "Florida" (4609) and Port au Prince, Haiti (133678). Gunter (above synonymy) records this species from the coast of Texas.

This species and *Decapterus punctatus* are the only Gulf species of the family Carangidae, which have a detached finlet behind the dorsal and anal fins, but otherwise the two species are not closely related. It differs from *D. punctatus* strikingly in lacking scutes in the lateral line, and in other characters, as may be gathered by comparing their accounts. Structurally this species is near *Seriola* as stated under its genus.

TRACHINOTUS Lacépède

Trachinotus Lacépède, Hist. Nat. Poissons 3: 78, 1802 (genotype *Scomber falcatus* Linnaeus by monotypy)

Deep to very deep depending on the species and stage of growth; well compressed; rather asymmetrical, apex of ventral contour placed a little more backwards than that of dorsal profile; peduncle deep (for a carangid) and compressed. Snout having a characteristic aspect, short, obtuse, its anterior profile nearly vertical. Adipose eyelid very moderately developed. Maxillary of very moderate width, short, ending under middle of eye, varying a little both ways; an elongate groove setting off an upper, posterior part of maxillary resembling a supplemental maxillary in shape, but without an evident suture along the groove. Mouth small, moderately inclined, subinferior, lower jaw moderately included. Teeth small; in narrow bands in jaws, that in lower jaw somewhat wider, disappearing with growth in *carolinus* and *falcatus*, persistent in *glaucus* and *marginatus*; present on head of vomer and palatines in *falcatus*, *glaucus* and *marginatus*, absent in *carolinus*, with growth disappearing in medium-sized specimens of *falcatus* and becoming reduced in *glaucus* and *marginatus*; absent on shaft of vomer; present in a rather narrow band on tongue in *falcatus* (disappearing in large specimens), absent in *carolinus*, *glaucus* and *marginatus*. Pseudobranchiae moderately developed in young, disappearing with growth (the only carangid genus here treated lacking pseudobranchiae). Gill rakers on upper limb 5–9, gradually decreasing in length at attached end, or 1–4 at end often short or mere tubercles; lower limb with 7–13 gill rakers and an indeterminate number of tubercles in front, so reduced and coalescent with one another as to be individually indistinguishable and hence their number not definitely determinable; number of gill rakers differing moderately with size, evidently some of the gill rakers changing to tubercles with growth (for these reasons, only number of gill rakers on lower limb that project appreciably above surface of arch, given in the species diagnoses, and the specimens examined divided into size groups for this purpose). Anus much nearer first anal spine than ventral base. Scales very small, partly embedded (not possible to count with any degree of precision); body almost altogether scaled; antedorsal area largely scaled to opposite preopercular margin, naked area on midback tapering backward to origin of spinous dorsal or a little short of origin; head scaleless; caudal scaled, other fins scaleless. Anterior curve in lateral line very low or hardly elevated; no scutes; accessory l.l. ending over posterior margin of head (often not discernible in large specimens of *carolinus*). First dorsal usually with 6 rather low spines; disconnected; pungent; increasing but slightly in length backward, almost subequal (the first spine often absent in *carolinus*); in young specimens spinous and soft dorsal continuous, the spines partly connected by membrane, well developed, stout, pungent, increasing gradually in length from first to seventh; with growth seventh spine becoming closely adherent to soft dorsal, the anterior 5 or 6 spines decreasing in length and becoming disconnected. Anal similar in structure and development to dorsal, the anterior two spines becoming disconnected with growth, short in large specimens. Dorsal and anal lobe moderately to excessively prolonged, depending on the species; fold at base of fins rather poorly developed; dorsal having 1–4 rays more than anal. Ventral rather short reaching about half the distance from its base to first anal spine. Pectoral slightly or hardly falcate, rather short, usually not reaching a vertical through first anal spine, sometimes reaching it. Caudal deeply forked, longer than head.

The species of this genus are recognizable by their shape; the variably deep body in combination with the characteristic truncate snout. It has a peculiar combination

of characters, namely, the shape of the body and snout; normally rounded, very small scales; absence of scutes; disconnected dorsal spines; presence of well developed anterior lobes on second dorsal and anal; absence of pseudobranchiae in the larger specimens. The species of *Trachinotus* carry the tendency toward a reduction in the dentition to an extreme.

Trachinotus, *Caesiomorus* Lacépède (genotype *Caesiomorus baillonii* Lacépède, as designated by Jordan and Evermann, 1917, p. 61) and *Hypodis* Rafinesque (genotype *Scomber glaucus* Linnaeus as designated by Jordan and Evermann, 1917, p. 79), constitute a group of related genera. *Trachinotus* has very small embedded scales which cannot be counted with a reasonable approximation to their true number, an asymmetrical body, a characteristically broad, blunt snout and the dorsal and anal lobes well developed to very long. The genotype of *Caesiomorus* has scales that are fairly countable, a snout the shape of which more nearly approaches the ordinary, and high dorsal and anal lobes. The genotype of *Hypodis* has very small, embedded scales, a snout nearly approaching the ordinary, low dorsal and anal lobes, a comparatively slender, symmetrically shaped body and comparatively numerous gill rakers. A more comprehensive discussion of the differences between, and the similarities of these three genera, must wait until all the known species concerned are studied in constructive detail and critically compared on a world wide basis, a task which still remains to be done.

TABLE XI

Frequency distribution of the number of anal and pectoral rays in four species of *Trachinotus*.

species	anal rays								pectoral rays				
	16	17	18	19	20	21	22	23	16	17	18	19	20
falcatus	....	15	9	....	....	....	....	....	....	....	2	14	1
glaucus	4	23	12	....	....	....	....	....	2	5	24	5	....
marginatus	....	4	3	....	....	....	....	....	....	....	4	3	....
carolinus	....	....	....	..	4	127	188	27	....	15	130	29	....

I was able to distinguish only three species among the specimens of *Trachinotus* examined from the east coast of the United States. One species, *carolinus*, is readily distinguished by the number of dorsal and anal rays. The other two species, *falcatus* and *glaucus*, are more difficult to distinguish externally. They are fairly distinguishable by the body depth in the smaller specimens, and by the length of the dorsal and anal lobes in larger fish, as discussed under the account of *falcatus*.

A fourth species, *goodei*, the so-called permit, is supposed to occur in southern Florida, according to current accounts; but I failed to distinguish a fourth species among some hundreds of specimens examined. The bulk of the specimens examined are small, but they included also a fair number of medium-sized and large fish. The alleged *goodei* is supposed to be characterized by a combination of having a body of medium depth and the dorsal and anal lobes of medium length. In table 12 it is shown that *falcatus* decreases in relative body depth with growth, and large specimens of *falcatus* have that combination of characters which is supposed to distinguish *goodei*. Therefore, my findings cast doubt on the reality of the name *goodei* as representing a distinct species. It seems that the fish which anglers and fishermen designate "permit," usually represent large specimens of *falcatus*. Perhaps also large

specimens of *carolinus* are sometimes so designated. Judged by the specimens examined, *glaucus* does not reach a large enough size to be designated "permit."

TABLE XII

Frequency distribution of body depth in three species of *Trachinotus*, expressed as a percentage of the standard length segregated by size, class headings referring to their mid numbers.

species	standard length in mm.	distribution 34	37	40	43	46	49	52	55	58	61	64	67	70	73
falcatus	13– 28	....	....	....	....	....	....	....	2	1	2	1	1	....	....
glaucus	14– 30	1	3	....	1	1	....	....	....	....	....	....	....	....	....
falcatus	32– 65	....	....	....	....	....	....	....	1	4	4	6	4	4	2
glaucus	33– 66	....	6	11	5	1	1	....	....	....	....	....	....	....	....
falcatus	71– 86	....	....	....	....	....	....	....	....	....	2	1	1	2	....
glaucus	67– 90	....	....	4	2	2	1	....	....	....	....	....	....	....	....
falcatus	101	....	....	....	....	....	....	....	....	....	....	....	1	....	....
glaucus	101–121	....	....	....	1	2	3	....	....	....	....	....	....	....	....
marginatus	108	....	....	....	....	1	....	....	....	....	....	....	....	....	....
falcatus	126–133	....	....	....	....	....	....	....	....	....	1	....	2	....	1
glaucus	124–145	....	....	....	....	....	4	....	....	....	....	....	....	....	....
marginatus	123–134	....	....	....	....	....	1	3	....	....	....	....	....	....	....
glaucus	159–167	....	....	....	....	....	....	2	2	....	....	....	....	....	....
marginatus	168	....	....	....	....	....	1	....	....	....	....	....	....	....	....
falcatus	172–251	....	....	....	....	....	....	....	1	2	2	1	....	....	....
glaucus	172–236	....	....	....	....	....	3	8	3	....	....	....	....	....	....
marginatus	225	....	....	....	....	....	....	1	....	....	....	....	....	....	....
falcatus	324–415	....	....	....	....	....	....	1	2	2	....	....	....	....	....
falcatus	574	....	....	....	....	....	1	....	....	....	....	....	....	....	....

The apparent existing misapprehension regarding the western Atlantic species of *Trachinotus* involves also a curious confusion of common and scientific names. In current accounts, the "permit" is generally treated under the name of *T. goodei.* However, as stated, the name "permit" apparently refers, partly or wholly, to large specimens of *falcatus;* while the type on which the name *goodei* is based, is evidently a small specimen of *glaucus* as noted under its account, and the name *goodei* must be entered in the synonymy of *glaucus.*

Trachinotus falcatus (Linnaeus)

Round pompano; permit (large fish),—Plate 3, fig. b; plate 4, fig.b

Labrus falcatus Linnaeus, Syst. Nat., p. 284, 1758 (America)

Chaetodon rhomboides Bloch, Ichthyologie ou Histoire Naturelle des Poissons, pt. 6, p. 75, pl. 209, 1788 (America, from a drawing by Plumier)

Trachynotus rhomboides Meek and Goss, Proc. Acad. Nat. Sci. Philadelphia 1884: 124 (Woods Hole to Brazil)

Trachinotus falcatus Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 941, pl. 146, fig. 396, 1896 (West Indies; Cape Cod to Brazil).—Nichols, Bull. Amer. Mus. Nat. Hist. 31: 186, 1912 (Havana market).—Meek and Hildebrand, Publ. Field Mus. Nat. Hist. Chicago (zool. ser.) 15(2): 378, pl. 33 (young), 1925 (Atlantic coast of Panama).—Nichols and Breder, Zoologica 9: 116, fig. 157, 1927 (Woods Hole, Mass.; Orient, N.Y.).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 228, figs. 133–134, 1928 (Chesapeake Bay).—Gunter, Copeia 1935(1): 40 (East Bay, Louisiana).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2): 721, fig. 322

(young), 1936 ("Tropical Atlantic").—Baughman, Trans. Texas Acad. Sci. 24: 23, 1941 (Rockport, Texas).—Longley and Hildebrand, Carnegie Inst. Washington Publ. 535: 80, 1941 (Tortugas, Florida).—Gunter and Knapp, Texas Jour. Sci. 3: 136, 1951 (Mustang Island, Texas)

D VI; I 18–20. A II; I 17–18. P 18–20. GR 9–11.

Gill rakers on lower limb 12–13 in 9 specimens 30 to 60 mm.; 9–11 in 10 specimens 85–495 mm. Body notably deep in small specimens, with growth the depth decreasing in proportion (see table 12). Teeth on jaws, vomer and palatines disappearing in medium sized specimens, and on tongue in large specimens. Prolonged dorsal lobe usually reaching approximately to a vertical through caudal base in the larger specimens, varying moderately both ways; the anal lobe considerably shorter than dorsal; dorsal lobe 38–49 in specimens 172–251 mm., the lobes comparatively shorter in the smaller and in very large specimens.

TABLE XIII

Frequency distribution of the length of the dorsal lobe in four species of *Trachinotus*, expressed as a percentage of the standard length, segregated into size groups, class headings referring to their mid numbers.

species	standard length in mm.	distribution 18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63	66	69	72	75	78	81	84
falcatus	13– 28	1	4	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
glaucus	14– 30	....	1	4	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
falcatus	32– 65	....	2	10	7	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
glaucus	33– 66	....	3	14	6	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
carolinus	50– 64	....	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
falcatus	71– 86	....	....	1	....	5	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
glaucus	67– 90	....	....	....	2	1	1	3	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
carolinus	67– 85	....	1	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
falcatus	101	....	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....
glaucus	101–121	....	....	....	....	....	....	1	2	2	1	....	....	....	....	....	....	....	....	....	....	....	....	....
marginatus	108	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
carolinus	109–115	....	....	2	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
falcatus	126–133	....	....	....	....	....	....	1	....	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....
glaucus	124–145	....	....	....	....	....	....	....	....	....	....	....	1	2	1	....	....	....	....	....	....	....	....	....
marginatus	123–134	....	....	....	1	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
carolinus	119–146	....	....	3	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
glaucus	159–167	....	....	....	....	....	....	....	....	....	1	....	....	1	....	....	....	....	....	....	2	....	....	....
marginatus	168	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
falcatus	172–251	....	....	....	....	....	....	....	1	2	....	1	....	....	....	....	....	....	....	....	....	....	....	....
glaucus	172–225	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	....	....	3	1	3	....	2	1
marginatus	225	....	....	....	....	....	....	....	1	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
carolinus	180–236	....	....	2	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
falcatus	330–415	....	....	....	....	....	....	....	2	1	1	....	....	....	....	....	....	....	....	....	....	....	....	....
carolinus	322–428	....	1	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

Silvery or golden, darker above, lighter below; elongate rays of dorsal and anal and broad marginal upper and lower areas on caudal dusky to nearly black; no cross bands or other distinctive marks. Small specimens are sometimes rather uniformly dark or dusky.

Gulf specimens examined from Tampa (market), Clearwater and Cedar Keys, Florida; Aransas Pass, Corpus Christi Pass, and Corpus Christi Bay, Texas. On the Atlantic coast specimens examined from Woods Hole, Massachusetts; Long Island, New York; Beesleys Point, New Jersey; Ocean View and Old Point Comfort, Virginia; Lake Worth, Marquesas Key, Key West and Tortugas, Florida. Also, Hog Island,

Bahamas; Cuba; Jamaica; Haiti; Dominican Republic; Puerto Rico; Colon and Toro Point, Panama; Sabanilla, Colombia; Lake Maracaibo, Venezuela; Porto Seguro, Brazil. The largest specimen is 790 mm. (31″) obtained in the New York Market. The largest Gulf specimen is 184 mm. (7″) from Corpus Christi Bay. Specimens examined from Massachusetts to Virginia are all small, the largest 98 mm.

A mounted specimen on exhibition at the National Museum, about 3 feet long, labeled "permit," looked at through the glass front of the exhibition case, appears to belong to this species. The body seems to be stouter than that of the specimens examined but this is probably an effect produced during the process of mounting.

TABLE XIV

Frequency distribution of the length of the anal lobe in four species of *Trachinotus*, expressed as a percentage of the standard length, segregated into size groups, class headings referring to their mid numbers.

species	standard length in mm.	distribution 19	22	25	28	31	34	37	40	43	46	49	52	55	58	61	64	67	70	73
falcatus	13– 28	1	3	1																
glaucus	14– 30	1	4	1																
falcatus	32– 65	2	18	2	1															
glaucus	33– 66	4	13	7																
carolinus	50– 64		1	1																
falcatus	71– 86		1	5																
glaucus	67– 90		1	3	2	2	1													
carolinus	67– 85	1	3																	
falcatus	101					1														
glaucus	102–121					1	1	2	1											
marginatus	108			1																
carolinus	109–115		3																	
falcatus	126–133				2	1	1													
glaucus	124–145									2	1	1								
marginatus	123–134		1	2	1															
carolinus	119–146		5	1																
glaucus	159–167									1		1				1	1			
marginatus	168				1															
falcatus	172–251				2	3														
glaucus	172–225												1		2	2	2		2	1
marginatus	225				1															
carolinus	180–236	1	1	2																
falcatus	330–574		2	1	2															
carolinus	322–332	1	1																	

This species has the same fin ray count as, and is near to *glaucus*. The bulk of the smaller specimens of *falcatus*, those less than 150 mm. in standard length, are usually distinguished on sight by their notably deep body; although the proper placement of occasional peripheral small fish by body depth is attended with some uncertainty. The proper distinction of the larger specimens is even more difficult. In *falcatus* the body becomes relatively more slender in the larger specimens, in those over 175 mm.; while in *glaucus* the relative depth increases steadily with growth. Consequently, the larger specimens of the two species closely approach in relative depth. However, in the larger specimens of *glaucus* the dorsal and anal lobes become greatly elongated and the two species are then fairly separable on that basis. The divergence between the two species in the length of the anal lobe is more pronounced than that of the dorsal lobe. In *glaucus* the anal lobe increases with growth nearly as much as the

dorsal lobe while in *falcatus* it increases at a slower rate. The change of measurements with size and the species differences are shown in tables 12 to 14.

The absence of dusky cross bars in *falcatus* and their presence in *glaucus* is of considerable help in distinguishing the two species. But the bars are absent in small preserved specimens of *glaucus* as well, and sometimes also in the larger preserved specimens. The distinguishing characters between this species and *marginatus* and *carolinus* are indicated under the accounts of those species.

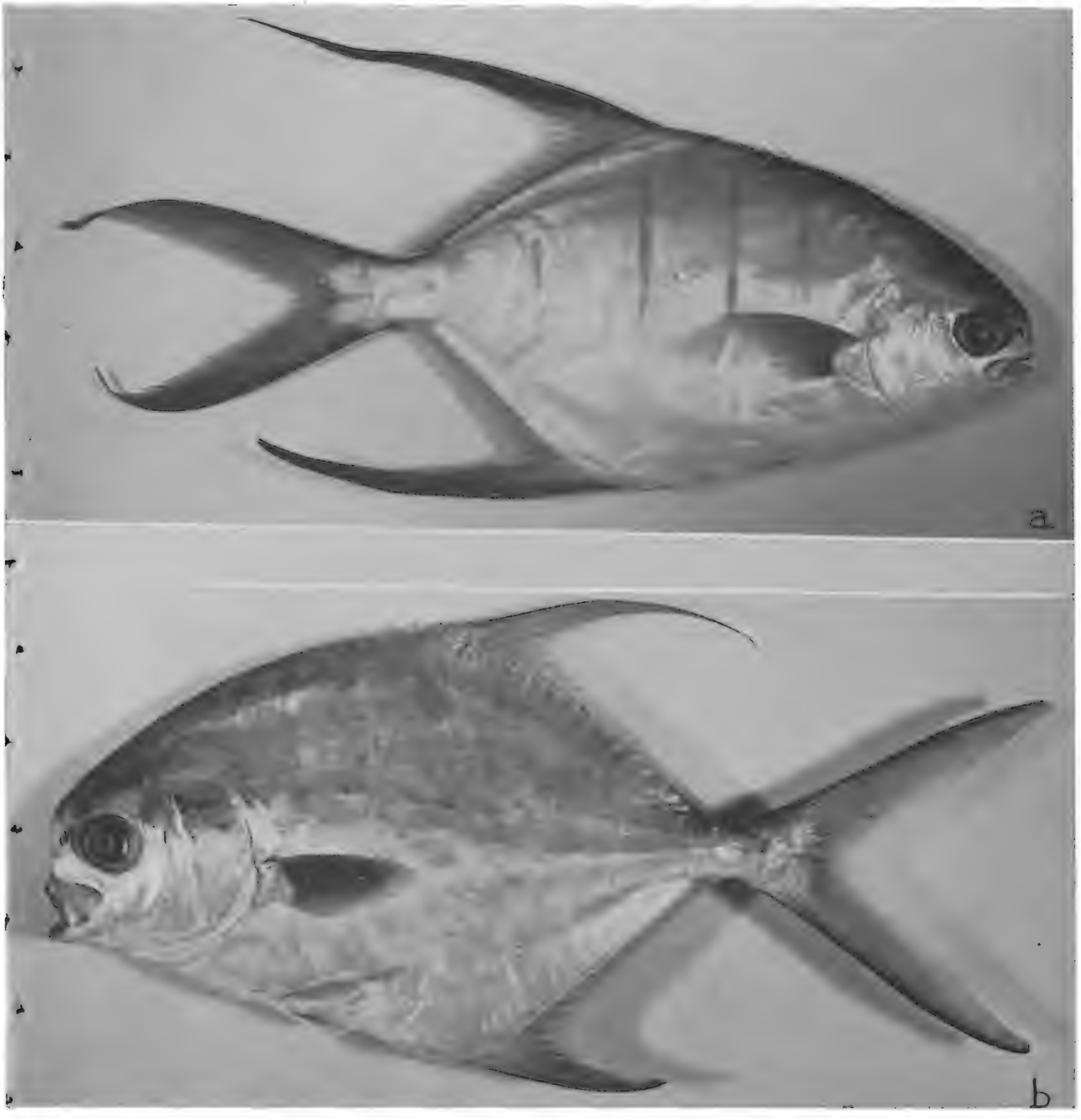

PLATE 3

Fig. a. *Trachinotus glaucus*, 292 mm Nassau, Bahamas. USNM 5314.

Fig. b. *Trachinotus falcatus*, 301 mm Florida. USNM 26585. In large specimens the body becomes comparatively not as deep and the dorsal and anal lobe relatively shorter. The species commonly called permit apparently refers to such large specimens of *falcatus*.

Trachinotus glaucus (Bloch)

Longfin pompano, Plate 3, fig. a; Plate 4, fig. a

Chaetodon glaucus Bloch, Ichthyologie ou Histoire Naturelle des Poissons, pt. 6, p. 76, pl. 210, 1788 (America, on a drawing by Plumier)

Trachinotus glaucus Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1) : 940, pl. 146, fig. 395, 1896 ("Tropical America, from Virginia to the Caribbean Sea").—Meek and Hildebrand, Publ. Field Mus. Nat. Hist. Chicago (zool. ser.) 15(2) : 382, pl. 36, fig. 1 (young), 1925 (Atlantic coast of Panama).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2) : 719, fig. 321, 1936 (Costa Rica; Santo Domingo)

Trachinotus goodei Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1) : 943, 1896 (The description of the holotype, "a small specimen from Key West," agrees with the species here treated.)

Trachinotus palometa Regan, Ann. Mag. Nat. Hist. (7) 12:349, 1903 (*palometa* substituted for *glaucus* after unacceptably placing *Scomber glaucus* Linnaeus in *Trachinotus* resulted in [Chaetodon] *Trachinotus glaucus* (Bloch) becoming a homonym).—Longley and Hildebrand, Carnegie Inst. Washington Publ. 535:81, 1941 (Tortugas, Fla.).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1) : 60, 1945 (Texas).—Baughman, Texas Jour. Sci. 2:246, 1950 (Texas).—Gunter and Knapp, ibid., vol. 3, p. 136, 1951 (Mustang Island, Texas)

D VI; I 19–20. A II; I 16–18. P 16–19. GR 8–11.

Gill rakers on lower limb 10–12 in 9 specimens 33–70 mm., 8–11 in 16 specimens 85–335 mm. Body moderately deep, with growth the depth increasing in proportion (see table 12). Teeth in jaws, on vomer and palatines persistent with growth but becoming reduced in extent on roof of mouth; absent on tongue. Prolonged dorsal and anal lobe reaching much beyond a vertical through caudal base in the larger

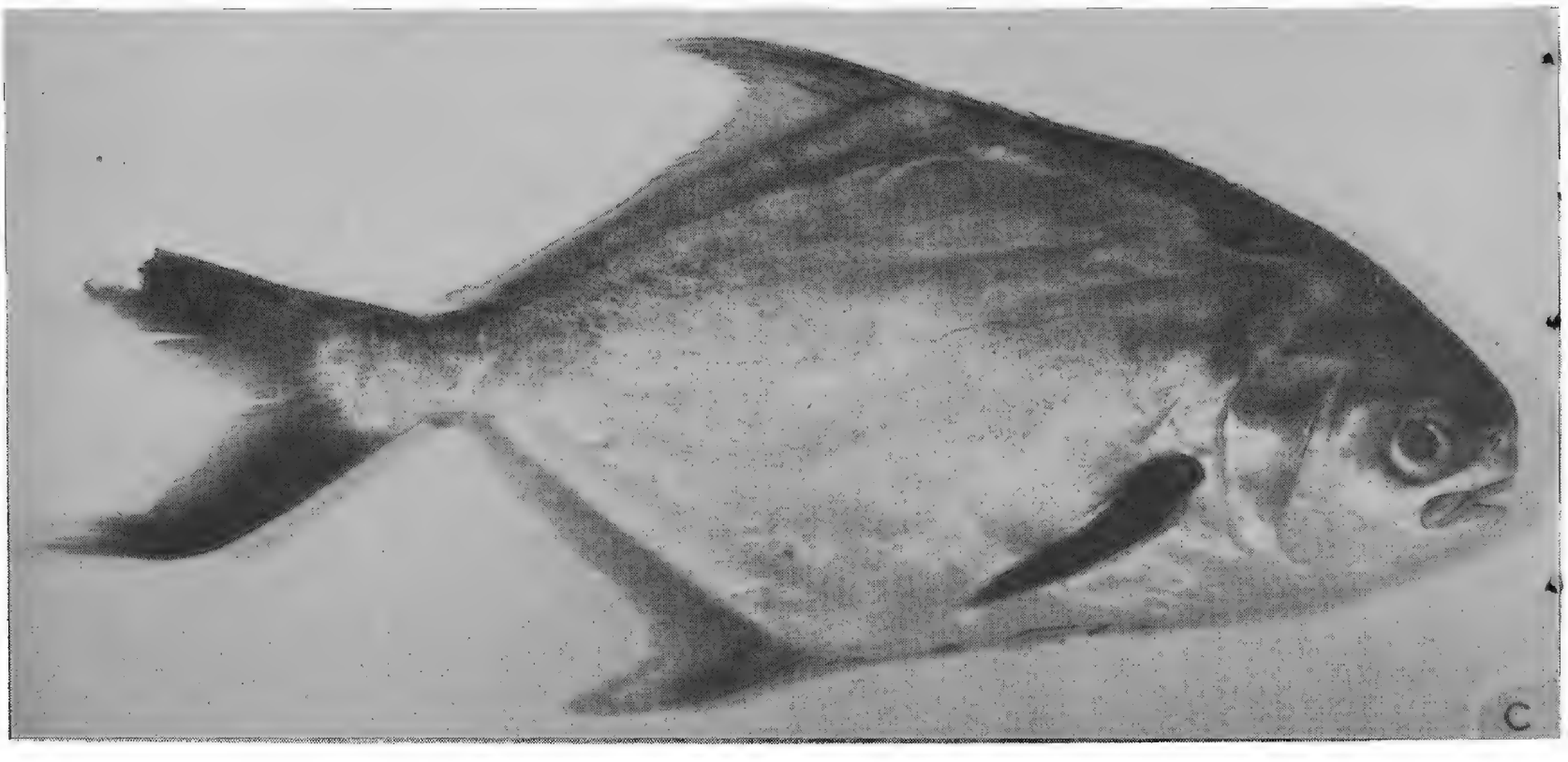

PLATE 3—(Continued)

Fig. c. *Trachinotus carolinus*, 322 mm Rio de Janeiro, Brazil, USNM 87792. Specimen figured having pectoral fin twisted and inner surface exposed.

specimens, anal lobe subequal to dorsal or moderately shorter; dorsal lobe 61–84 in specimens 172–225 mm. in standard length; the lobes comparatively shorter in the smaller specimens.

Ground color silvery or golden; with 4 brownish cross bars on upper part of body; the first a little in front of first dorsal spine; the fourth nearly under middle of soft dorsal, more widely spaced and shorter than anterior three bars, sometimes very short or absent in preserved specimens; the first three bars extending over the greater part of the distance between lateral line and midback and continued for a short distance

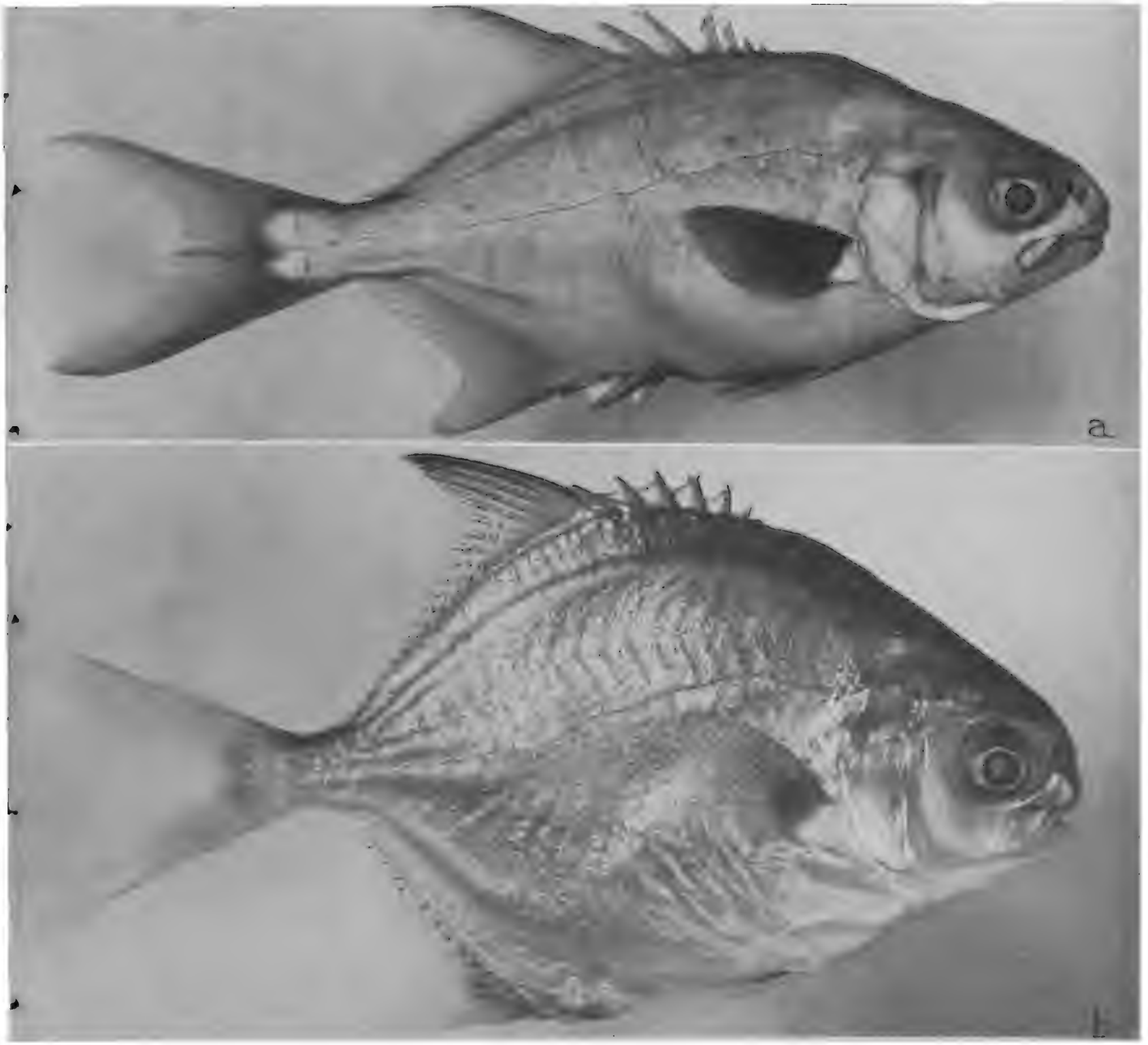

PLATE 4

Small specimens of the three species of *Trachinotus* on the east coast of the United States. The fins relatively short in all three species.

Fig. a. *Trachinotus glaucus*, 87 mm Tortugas, Fla. USNM 143952.

Fig. b. *Trachinotus falcatus*, 81 mm Old Point Comfort, Va. USNM 143941. Body depth very striking, relatively deeper than in adult.

below 1.1.; caudal peduncle often with one or two brownish spots at lateral line, one behind the other; elongate dorsal and anal rays and a broad outer area on caudal lobes dark to nearly black. In small preserved specimens the cross bars are not evident and they are sometimes faint or hardly perceptible in the larger specimens.

Gulf specimens examined from Pensacola, Florida; Aransas Pass, Texas; Louisiana. On the Atlantic coast specimens examined from Woods Hole, Marthas Vineyard, Massachusetts; Beaufort, North Carolina; St. Augustine, Marquesas Key, Key West and Tortugas, Florida. Also from Nassau, Bahamas; Cuba; Puerto Rico; Old Providence Island; Cozumel Island, Mexico; Honduras; Colon, Panama; Sabanilla, Colombia; Gulf of Venezuela; Rio de Janeiro and Porto Inhauma, Brazil. The largest specimen is 335 mm. (13″) from Panama. The largest Gulf specimen is 300 mm. (12″) from Pensacola.

PLATE 4—(Continued)

Fig. c. *Trachinotus carolinus*, 89 mm Galveston, Texas. USNM 118663.

Fig. d. *Trachinotus carolinus*, 130 mm, 101 mm in standard length. Grand Isle, La. USNM 118968. A size at which about maximum depth is attained. Such deep specimens sometimes designated *T. argenteus*.

The larger specimens of this species are usually distinguishable at a glance by the combination of having the dorsal and anal lobe much prolonged, a body of medium depth and comparatively long, dusky cross bars. It is further compared with *marginatus, falcatus* and *carolinus* under the accounts of those species.

Nomenclature.—Regan (cited in synonymy) substitutes the name *palometa* for this species, on the assumption that *Scomber glaucus* Linnaeus (1758) belongs to *Trachinotus,* which causes the *T. glaucus* of Bloch (1788) to become a homonym. However, Regan's generic placement of *S. glaucus* L., is unacceptable as it differs generically from *Scomber falcatus* Linnaeus which is the genotype of *Trachinotus.* (Linnaeus' species has been designated as the genotype of *Hypodis* Rafinesque by Jordan and Evermann, 1917, p. 79.) Besides, this species has a synonym, *goodei,* as indicated in the above synonymy, which antedates *palometa* of Regan.

Trachinotus marginatus Cuvier and Valenciennes

Plate 5, fig. a

Trachinotus marginatus Cuvier and Valenciennes, Hist. Nat. Poiss. 8: 411, 1831 (sent in from Montevideo)

D VI; I 19–21. A II; I 17–18. P 18–19. GR 11–12.

Gill rakers on lower limb 10–12 in 7 specimens 148–320 mm. Body moderately deep (see table 12). Teeth in jaws on vomer and palatines in specimens 148–230 mm., in reduced number in jaws and very few or absent on palatines and vomer in one specimen 320 mm.; absent on tongue in all. Dorsal and anal lobes falling short of a vertical through caudal base; dorsal lobe 38 in a specimen 225 mm. in standard length.

Ground color golden or silvery upper part brownish, rather dark in largest specimen; with a row of 4 or 5, transversely oblong dark spots or short bars at lateral line, the row beginning approximately under middle of spinous dorsal and ending a little in front of end of soft dorsal; larger part of spots extending moderately above lateral line, their lower ends touching l.l. or extending a little below; the spots well marked in the largest specimen, rather faint or hardly perceptible in smaller fish; pectoral, and dorsal, anal and caudal lobes dark to nearly black.

Specimens examined: Rio de Janeiro (76320), Montevideo, Uruguay (77311), Uruguay (86713, 87728). Total examined 7 specimens, 148–320 mm. The four lots of specimens sporadically obtained by various collectors would seem to indicate that the species is not uncommon on the coast of South America.

This species nearly agrees with *falcatus* and *glaucus* and differs from *carolinus* in the number of dorsal and anal rays. It differs from *falcatus* in having transversely elongate spots or short bars and in not having the body as deep as in that species. In the depth of the body it nearly agrees with *glaucus* and differs from it in having the dorsal and anal lobes and the cross markings shorter.

Trachinotus carolinus (Linnaeus)

Common pompano, Plate 3, fig. c; Plate 4, figs. c and d

Gasterosteus carolinus Linnaeus, Syst. Nat., ed. 12, t. 1, p. 490, 1766 (Carolina)

Trachinotus carolinus Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 944, pl. 147, fig. 398, 1896 ("South Atlantic and Gulf coasts of United States, ranging

north to Cape Cod . . . rare or accidental in the West Indies and in Brazil").—Nichols and Breder, Zoologica 9:117, fig. 160, 1927 (Woods Hole, Mass.; New York).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 229, fig. 135, 1928 (Chesapeake Bay).—Gunter, La. Conserva. Rev. 5(4): 22, 1936 (Louisiana).—Longley and Hildebrand, Carnegie Inst. Washington Publ. 535: 81, 1941 (Tortugas, Fla.).—Baughman, Trans. Texas Acad. Sci. 24:23, 1941 (Texas).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1): 59, 1945 (Texas; life history notes).—Baughman, Texas Jour. Sci. 2: 246, 1950 (Texas)

Trachinotus argenteus Cuvier and Valenciennes, Hist. Nat. Poiss. 8:413, 1831 (sent in from New York and Rio de Janeiro).—Smith, Bull. U. S. Fish. Comm. 17:98, 1898 (a specimen from Woods Hole identified by Baird as argenteus).—Bean, Nineteenth Rep. Comm. Fish. New York, p. 257, fig. 13, 1890 (Blue Point Cove, Long Island).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 944, 1896 ("Atlantic Coast").—Nichols and Breder, Zoologica 9: 116, fig. 159, 1927 (Woods Hole).—Nichols, Marine Life 1(8): 41, 1950 (off Long Island)
D V—VI; I 23–27. A II; I 20–23. P 17–19. GR 7–11.

Gill rakers on lower limb 9–11 in 4 specimens 65–85 mm., 7–10 in 17 specimens 90–570 mm. Body moderately deep (for a *Trachinotus*), changing with growth (see table 15). Teeth present in jaws; absent on vomer, palatines and tongue; with growth disappearing in jaws. Dorsal and caudal lobe moderate, subequal, reaching to about middle of dorsal and anal base; dorsal lobe 25–27 in specimens 180–236 mm. First dorsal spines often 5 (see table 10).

Silvery, with a grayish tinge on upper half, lighter below; fins dusky in the larger specimens, usually almost uniformly so; no cross bands.

Gulf specimens examined from Clearwater Beach, Apalachicola Bay, Sand Island, St. Vincent Island, Cape San Blas and Pensacola, Florida; Chandeleur Islands, Grande Terre, Grande Isle, Caminada Pass and Isle Derniere, Louisiana; Galveston, Matagorda Bay, Pass Cavallo, St. Joseph Island, Aransas Pass, Corpus Christi Bay and Corpus Christi Pass, Texas. On the Atlantic coast of the United states specimens examined range from Woods Hole, Massachusetts to Key West, Florida. Specimens also examined from Merida, Yucatan, Mexico; Puerto Rico; Fort Sherman, Panama; Sabanilla, Colombia; Gulf of Venezuela; Pernambuco, Santos, Rio de Janeiro and Porto Inhauma, Brazil. The largest specimen, 570 mm. (25″) is from New York (most probably obtained in market). The largest Gulf fish is 440 mm. (17″) from Pensacola.

This species is readily separable from *falcatus, glaucus* and *marginatus* by the number of soft dorsal and anal rays, there being no intergradation with the other three species in these counts in *carolinus*. It differs further from *marginatus* and *glaucus* in not having cross bands or elongate spots, and from *falcatus* in not having the body as deep. In its comparatively low dorsal and anal lobes it is nearest *marginatus*.

Ontogeny.—This species undergoes considerable change with growth in its body depth, as shown in table 15. The relative depth first increases and, on the whole, reaches its maximum in fish between 110–130 mm. in standard length. After that size is attained the relative depth decreases. At a given size range individual variants may be either advanced or retarded in the development of body depth. Table 15

includes measurements of specimens from the entire geographic range of the species and no account was taken of any possible population differences in body depth, or differences in its tempo of change with growth by locality.

TABLE XV

Frequency distribution of the body depth of *Trachinotus carolinus*, expressed as a percentage of the standard length, segregated into size groups.

standard length in mm.	distribution 32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
12– 15	....	1	3	6	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
16– 20	1	....	....	2	2	4	8	3	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
21– 25	....	....	....	1	4	6	2	3	2	....	....	....	....	....	....	....	....	....	....	....	....	....	....
26– 30	....	....	....	1	1	2	4	5	5	4	1	....	....	....	....	....	....	....	....	....	....	....	....
31– 40	....	....	....	....	2	3	9	7	10	15	5	5	4	1	....	....	....	....	....	....	....	....	....
41– 50	....	....	....	....	....	1	4	2	9	1	11	10	4	5	....	....	1	....	....	....	....	....	....
51– 65	....	....	....	....	....	....	2	5	5	4	8	14	11	4	4	3	1	....	....	....	....	....	....
66– 80	....	....	....	....	....	....	....	....	....	....	2	2	3	5	3	5	4	3	2	....	....	....	1
81– 95	....	....	....	....	....	....	....	....	....	....	....	....	2	4	6	6	2	3	1	1	2	1	....
97–109	....	....	....	....	....	....	....	....	....	....	....	....	....	....	3	2	2	2	2	3	....	1	1
111–129	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	2	2	4	2	1
134–274	....	....	....	....	....	....	....	....	....	....	....	....	....	....	1	1	4	5	1	1	1	2	....
285–428	....	....	....	....	....	....	....	....	1	1	1	....	1	1	....	....	....	....	....	....	....	....	....

Small specimens are rather symmetrically shaped, and the greatest body depth is at about the middle of the belly. However, with growth the fish becomes somewhat asymmetrical, the apex of the ventral outline which coincides with the anal origin, is a little more posterior to the apex of the dorsal profile which coincides with the dorsal origin. In the latter specimens the depth was measured on the greatest vertical which is at the dorsal origin. Therefore, the depth in the smaller specimens was also measured on a vertical at the same point, although it does not represent the greatest depth in such specimens. The table shows the precise change with growth in the depth at the point measured, which is somewhat less than the greatest depth in the small specimens.

The number of dorsal spines in *carolinus* varies considerably with the individual. This variability is based on the first spine. It is normally short, varying to a slight stump hidden under the skin; and often it is absent altogether, in 51 specimens out of 346 examined for this character, as shown in table 10. This variability in the first spine is shown by small as well as large specimens. In addition to this individual variation, there appears to be a growth change also, as shown by

Standard length		Number of spines 6	7
class	12– 50	frequency 13	166
class	51–274	frequency 34	128
class	285–428	frequency 4	1

the accompanying tabulation. All the spines become shorter with growth, and it appears that in large fish the first spine usually disappears.

Populations.—Table 16 shows considerable differences by local population in the frequency distribution of the dorsal and anal rays and dorsal spines. The distribution is virtually the same in the samples ranging from Buzzards Bay to Chesapeake Bay. The population of North Carolina averages higher fin ray counts. The highest average

fin ray counts obtains in the population from northwestern Florida; while the Louisiana and Texas populations differ only slightly from those at the northern part of the geographic range of the species. The South American populations, especially that of Venezuela, are characterized by averaging low counts. The samples examined from Colombia and Venezuela constantly have 7 dorsal spines.

TABLE XVI

Population differences in the frequency distribution of the number of dorsal and anal rays and dorsal spines in *Trachinotus carolinus*.

locality	dorsal spines		dorsal rays					anal rays			
	6	7	23	24	25	26	27	20	21	22	23
Buzzards Bay, Mass.	7	20	2	19	16	....	....	1	8	17	1
Noank, Conn. to Longport, N. J.	8	21	2	17	9	....	....	1	11	16	1
Chesapeake Bay, at its mouth	6	21	3	15	9	....	....	....	11	15	1
Beaufort, N. C.	10	45	2	29	18	6	....	....	17	31	8
Apalachicola to Pensacola, Fla.	6	44	....	13	30	5	1	....	6	32	12
Chandeleur Ids. to Isle Derniere, La.	5	43	5	25	18	....	....	1	21	26	....
Galveston to Aransas Pass, Texas	5	43	7	29	12	....	....	....	22	23	3
Sabanilla, Colombia	....	34	7	23	2	1	....	....	18	16	....
Gulf of Venezuela	....	9	7	2	....	....	....	....	6	2	....
Brazil	1	6	1	4	2	....	....	1	2	2	1

Data presented by Gunter (Pub. Inst. Marine Sci., vol. 1, no. 1, 1945) indicate that *T. carolinus* is by far the most abundant pompano on the Gulf Coast. He called attention to the great numbers of young along the Gulf beaches in summer.

Synonymy.—A species of *Trachinotus* closely related to *carolinus*, has been recorded by some authors from eastern United States, under the name of *argenteus*, as noted in the above synonymy. The only character hitherto advanced for distinguishing the supposed *argenteus* from the common *carolinus*, is its surmised greater depth of body. However, a determination of the growth change in the body depth of *carolinus* and its intraspecific variability at any given narrow size range, as is shown in table 15, puts this question in its proper perspective. At any given size, *carolinus* shows considerable variability in the body depth; while the maximum depth attained by *carolinus*, in the 110–130 mm. size group, is somewhat greater than the depth of the alleged *argenteus*, given by those authors who claim that it constitutes a distinct species. Certainly, no distinct species can be established on the basis of the given depth difference alone in the absence of corroborating characters. It is evident that *argenteus* should be erased from the list, at least as far as it relates to eastern United States.

One of the specimens previously recorded as *argenteus*, the one recorded by Bean (1890) from Long Island (36036), has been reexamined. It has an unusually deep body for its size. It is the extreme specimen in the 66–80 mm. category in table 15. The appearance of the specimen is such that when compared with the more slender specimens in its size group, one might tentatively conclude that it belongs to a different species. However, a comparison of its depth measurement with the frequency distribution of *carolinus*, in its and adjacent size group, the striking depth of this specimen loses its significance as a specific character. A study of table 15, suggests two possible explanations for the unusual depth, at its size. First, it might be a stunted specimen of approximately the same age as the specimens in category 110–

130 mm., and its deep body is in accordance with its age. Second, it might be that it is a precocious specimen which developed the body form of the larger and older fish.

SELAR Bleeker

Selar Bleeker Nat. Tijdschr. Ned. Indie 1:343, 352, 353 and 359–362, 1850 (genotype *Selar boops* (Cuvier and Valenciennes) by later designation).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 916, 1896 (*Caranx boops* Cuvier and Valenciennes designated as genotype).—Fowler, Proc. Acad. Nat. Sci. Philadelphia 1918:14 (*Caranx boops* Cuvier and Valenciennes designated genotype)

Trachurops Gill, Proc. Acad. Nat. Sci. Philadelphia, 1862:238 (genotype *Caranx plumieri* (Bloch) = *Scomber plumieri* Bloch = *Scomber crumenophthalmus* Bloch by monotypy)

Selar is nearest *Decapterus* and *Trachurus*. It differs from *Decapterus* in that the last dorsal and anal rays, although notably thickened, are not detached to form separate finlets. It differs from *Trachurus* in having two well developed papillae on the shoulder girdle and in not having the anterior scales in the lateral line greatly expanded transversely.

Nomenclature.—Nichols (1942) who claims that *boops* cannot be the genotype of *Selar*, because it is not one of the originally included species, evidently overlooked one of the pages in Bleeker's paper establishing this genus. On page 343 in the work cited in the above synonymy, where the name *Selar* is used for the first time, Bleeker gives a bare list of 12 species combined with this generic name. One of the included species is given as "*Selar boops* Blkr. = *Caranx boops* C.V." This species was subsequently designated as the genotype of *Selar* twice, once by Jordan and Evermann and later by Fowler as noted above. According to Articles 25 and 30 of the international code, and Opinion 1 of the international commission, *Selar* is a valid genus with *Caranx boops* Cuvier and Valenciennes as its genotype.

On page 352 Bleeker gives a definition of *Selar* without mentioning any species. On page 353 he gives a brief discussion of the genus and mentions three species, *plumieri*, *analis* and *djeddaba*. On pages 359–362 he gives descriptions of five species, *macrurus*, *hasseltii*, *kuhlii*, *brevis* and *malam*. All this is really beside the point. These facts are mentioned here, because Nichols depended on the record in these later pages to draw a seemingly correct conclusion regarding the genotype of *Selar*, but one which is in reality untenable.

For the common species *crumenophthalmus*, American authors have widely used the generic name *Trachurops* for a long time. From the viewpoint of American authors then it would seem desirable to preserve this well established name. However, for the extra-American species of the same genus, as used by other authors especially, the name *Trachurops* did not command any extensive usage, and in this instance it seems best to follow the Rules.

Selar crumenophthalmus (Bloch)

Bigeye scad

Scomber crumenophthalmus Bloch, Ichthyologie ou Histoire Naturelle des Poissons 10:65, pl. 343, 1797 (Guinea)

Scomber plumieri Bloch, ibid. p. 67, pl. 344 (Antilles)

Caranx crumenophthalmus Gunther, Cat. Fish. Brit. Mus. 2:429, 1869 (Atlantic and Pacific localities)

Trachurops crumenophthalmus Gill, Proc. Acad. Nat. Sci. Philadelphia 1862: 432 (Beesley's Point, New Jersey).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 911, pl. 141, fig. 385, 1896 ("Both coasts of tropical America, occasionally north to Cape Cod . . .").—Nichols, Bull. Amer. Mus. Nat. Hist. 31:185, 1912 (Cuba).—Nichols, Copeia 1920: 96 (Long Island).—Nichols and Breder, Zoologica 9: 111, fig. 149, 1926 (Woods Hole, Mass.; Orient, N.Y.).—Nichols, Amer. Mus. Novit. 815:1, 1935 (Pacific localities).—Longley and Hildebrand, Carnegie Inst. Washington Publ. 535: 76, 1941 (Tortugas, Florida).—Fowler, Monog. Ac. Nat. Sci. Philadelphia 6: 149 and passim, 1944 (various Atlantic and Pacific localities scattered through the pages)

Selar crumenophthalmus Fowler, Proc. Acad. Nat. Sci. Philadelphia 1918: 15 (Philippine Islands).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 217, fig. 126, 1928 (Chesapeake Bay).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2): 689, fig. 309, 1936 (United States; West Indies; Cape Verde Islands)

D VIII; I 24–26. A II; I 21–23. P 20–22. Scutes 30–41. GR 27–30.

Dorsal rays usually 25 (10) or 26 (8), sometimes 24 (1). Anal rays modally 22 (14), often 23 (3) or 21 (2). Dorsal spines constant (19). Pectoral rays modally 21 (17), sometimes 20 (1) or 22 (1). Gill rakers long, 9–11+27–30, sometimes one tubercle at anterior end of lower limb; total number of gill rakers and tubercles on both limbs 37–41. Body moderately slender, rather spindle shaped, depth 25–29 in 11 specimens 65–270 mm.; caudal peduncle moderately slender. Snout moderate, subequals eye, obtuse. Eye notably large. Adipose eyelid very well developed, covering greater part of eye. Maxillary of moderate width, ending under anterior margin of pupil; supplemental maxillary rather narrow. Mouth medium, well inclined, subsuperior, lower jaw projecting. Teeth small, in one row in lower jaw, two rows in upper jaw; in a narrow band on head of vomer and on palatines; a narrow, short forward extension on head of vomer, none on shaft; a rather wide or medium band on tongue. Shoulder girdle with two widely separated, coarse papillae, the upper one but slightly rising, the lower one conspicuously well developed. Anus placed at a moderate distance from first anal spine. Scales small; antedorsal area and interorbital scaled nearly to opposite anterior margin of eye; cheek, opercle and interopercle largely scaled; fins more or less scaled. Anterior curve in lateral line very low, continued very gradually into posterior straight part; scales in posterior part scute-like, 30–41; scales in anterior part of l.l. normally rounded, not scute-like, 50–58; total number of scales in l.l. 84–93; accessory l.l. ending under beginning or middle of first dorsal. First dorsal rather high, the spines connected by membrane, the anterior spines rather flexible; first spine comparatively long and thin, about one half the third and longest; fourth spine shorter than or subequal to third; thence rapidly decreasing to last. The two disconnected anal spines well developed. Dorsal and anal lobe moderately elevated; fold at their base moderate; dorsal having 2–4 more rays than anal. Ventral moderately long, reaching more than half the distance from its base to soft anal origin; its outer angle under lower pectoral angle or slightly behind. Pectoral moderately long about reaching over beginning of soft anal in large specimens. Caudal rather short, shorter than head, well lunate.

Silvery or golden, almost uniformly colored or upper part dark; a marginal spot on opercle rather faint or absent; no distinctive color marks.

Only 2 Gulf specimens, 115–185 mm. examined from off Isle Dernière and Grand Isle, La. On the Atlantic coast of the United States specimens examined range from Woods Hole, Mass. to Norfolk, Va., and from Tortugas, Fla. Also, from Bermuda; Nassau, Bahamas; Cuba; Cozumel Island, Mexico; Honduras; Puerto Rico; St. Thomas Island; Barbados; Old Providence Island; Curacao; Porto Bello, Panama; Bahia, Brazil. The largest specimen is 270 mm. (11″) from Cuba.

As compared with the Gulf fishes, this species is nearest structurally and in general appearance to *Decapterus punctatus* and *Trachurus lathami*. The main structural differences between the species are discussed under the genus. This species has a notably large eye which is largely covered by the well developed adipose eyelid, except for a moderate open slit at the middle. This feature in combination with the other structural characters discussed above, makes it easy to identify and distinguish it from the other Gulf species.

DECAPTERUS Bleeker

Decapterus Bleeker, Nat. Tijdschr. Nederl. Ind. Batavia 1: 342, 352 and 358, 1850 (two species included, *kurra* and *macrosoma;* genotype *Caranx kurra* Cuvier and Valenciennes by later designation).—Jordan and Gilbert, Bull. U. S. Nat. Mus. 16: 432, 1882 (*Caranx kurra* C. and V. designated as genotype)

Decapterus is near to *Selar*, nearly agreeing with it in most generic characters, including the presence of two papillae on the shoulder girdle. It differs in having a detached finlet behind the dorsal and anal fins. It should be noted that the species of this family have the last dorsal and anal ray more or less thicker and somewhat longer than the preceding ray. In *Decapterus* this ray became detached to form a separate finlet. The development of finlets in some species of Carangidae, evidently appeared independently in different lines of descent as discussed above.

Decapterus punctatus (Agassiz)

Round scad

Caranx punctatus Agassiz in Spix, Selecta genera et species piscium Brasiliensium, p. 108, pl. 56a, fig. 2, 1829 (Brazil)

Decapterus punctatus Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 907, 1896 (Cape Cod to Brazil).—Nichols and Breder, Zoologica 9: 110, fig. 146, 1927 (Woods Hole, Mass.; Orient, N.Y.).—Norman, Ann. Mag. Nat. Hist. (10)16: 254, 1935 (Cape Cod to Brazil; Cape Verde Ids.).—Fowler Bull. Amer. Mus. Nat. Hist. 70(2): 685, fig. 308, 1936 (West Indies).— Longley and Hildebrand, Carnegie Inst. Washington Publ. 535: 75, 1941 (Tortugas, Florida)

D VIII; I 28–32; 1. A II; I 25–27; 1. P 19–21. Scutes 36–44. GR 34–40.

Dorsal rays 28 (1), 29 (2), 30 (5), 31 (3) or 32 (2). Anal rays modally 26 (7), very often 25 (3) or 27 (3). Dorsal spines constant (12). Pectoral rays modally 20 (9), often 19 (2) or 21 (2). Gill rakers long, 12–15+34–40, and a tubercle sometimes at distal end of lower limb; total number of gill rakers and tubercles on both limbs 47–55. Body slender, spindle shaped, depth 19–23 in 12 specimens 67–161 mm. in standard length; caudal peduncle slender. Snout moderate, subequals eye, obtuse. Adipose

eyelid well developed, more so posteriorly. Maxillary comparatively rather wide ending under anterior margin of eye; supplemental maxillary moderate. Mouth small, terminal, strongly inclined to a vertical. Teeth small; in one row in both jaws; teeth in upper jaw sparse, confined to anterior part of jaw; in a narrow band on head and shaft of vomer and on palatines, that on shaft extending far backward; in a rather broad band on tongue. Transverse margin of shoulder girdle forming a shallow curve, edged by thick skin forming a moderate, papilla-like projection at its upper and lower extremity, lower papilla somewhat better developed than upper (papillae similar to those in *Selar crumenophthalmus*, except lower one not as well developed). Anus placed near first anal spine. Scales small; antedorsal area scaled to opposite anterior margin of pupil or eye; cheek, opercle and interopercle largely scaled; fins more or less scaled. Anterior curved part of lateral line rather low, continuous rather gradually with posterior straight part; all scales in straight part of l.l. scute-like, 36–44; scales in curved part normally rounded, not scute-like, 41–55; total number of scales in l.l. 80–93 (given ranges based on 12 specimens); accessory l.l. short, curving upward to meet its fellow at a point on midback approximately over posterior margin of head. First dorsal rather high, the spines connected by membrane, the anterior ones rather flexible; first spine moderately short, about one-third as long as third and longest; fourth spine subequal to third or moderately shorter; thence rapidly decreasing backward. The two disconnected anal spines fairly developed. A detached finlet at a short distance behind dorsal and anal consisting of one thick, much branched ray. Dorsal and anal lobe and fold at base of fins moderate; dorsal having 3–6 rays more than anal. Ventral rather short, reaching half the distance from its base to origin of soft anal or a little less; its outer angle slightly behind a vertical through lower pectoral angle. Pectoral rather short, extending a moderate distance beyond end of ventral. Caudal shorter than head.

Upper part dark brownish, lower part silvery with a golden tinge; opercle with a black spot near its upper angle; a row of small dark spots along anterior part of lateral line; a series of faint dusky, transverse streaks on anterior lower part of body. The above color description is from one well preserved specimen from Panama. All other specimens examined are more or less faded and show only traces of one or another of the above color marks.

Gulf specimens examined from Pensacola, off Pepperfish Key, and off Clearwater, Florida. Also from Woods Hole, Massachusetts; Newport, Rhode Island; off Cape Lookout, North Carolina; off Titusville, Florida; Bermuda; Cuba; Puerto Rico; Porto Bello, Panama; Bahia, Brazil. The largest specimen is 190 mm., from Bermuda. The largest Gulf specimen is 175 mm. (7″).

This species is easily identified. It is the only Gulf species which has a finlet behind the dorsal and anal fins in combination with well developed scutes in the posterior part of the lateral line. It differs from *macarellus*, the other known species of *Decapterus* in the western Atlantic in having fewer total scales in the lateral line but the scales that are in the form of scutes are greater in *punctatus*. The latter also has fewer pectoral rays.

In 4 specimens of *macarellus*, 3 from Woods Hole and 1 from Puerto Rico, the total number of scales is 126–131; 66–68 in anterior curved part of lateral line; 59–65 in posterior straight part of which the last 28–37 are in form of scutes. Comparing with the counts given above for 12 specimens of *punctatus*, the greatest divergence between

the two species is found in the total scale count in the lateral line, including the scutes. However, one specimen from New Smyrna has a total of 108 scales, 64 in curved part and 3 scales and 41 scutes in the straight part. The total number of scales in this variant is, therefore, intermediate of that determined for the few specimens of each species, while the count in the straight part of the l.l. is nearly as in *punctatus*.

The four specimens of *macarellus* have 22–24 pectoral rays, while 13 specimens of *punctatus* have 19–21. The New Smyrna variant has 22. Judged by the few specimens compared, it is reasonable to expect that a study of adequate samples will show that these two species closely approach or overlap in the scale count, and possibly also in the pectoral count.

The data for these few specimens also show that *punctatus* averages fewer dorsal and anal rays and more gill rakers; but the two species well overlap in these characters.

Taking all characters into consideration, the New Smyrna variant seems to be a *macarellus*. Also, all specimens examined from the Gulf are referable to *punctatus*, and on the basis of existing evidence *macarellus* does not occur in the Gulf.

TRACHURUS Rafinesque

Trachurus Rafinesque, Indice D'Ittiologia Siciliana, p. 20, 1810 (genotype *Trachurus saurus* Rafinesque=*Scomber trachurus* Linnaeus by tautonymy)

The nearest relatives of this genus among the Gulf carangids are *Selar* and *Decapterus*. It differs from both in having the anterior scales in the lateral line transversely expanded to a notable extent, and in lacking papillae on the shoulder girdle.

Trachurus lathami Nichols

Rough scad

Trachurus trachurus Jordan and Evermann (in part), Bull. U. S. Nat. Mus. 47(1): 910, pl. 140, fig. 384, 1896 (Newport, R.I.; Pensacola)

Trachurus lathami Nichols, Bull. Amer. Mus. Nat. Hist. 42: 479, 1920 (Orient, Long Island).—Nichols and Breder, Zoologica 9: 110, fig. 148, 1927 (Woods Hole, Mass.; Orient, N.Y.).—Nichols, Amer. Mus. Novit. 1067: 1, 1940 (Gulf of Mexico).—Baughman, Trans. Texas Acad. Sci. 24:22, 1941 (Galveston).—Merriman, Copeia 1943 (4): 205 (Newburyport, Mass.).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1 (1): 57, 1945 (off Port Aransas, Texas)

D VIII; I 28–33. A II; I 26–30. P 21–22. GR 34–37.

Dorsal spines constant (in 46; for variability in dorsal and anal rays see table 17). Pectoral rays 21 (7) or 22 (5). Gill rakers long, 12–14+34–37, sometimes a tubercle at either end of the arch; total number of gill rakers and tubercles on both limbs 47–51 (in 9 specimens). Slender (see table and discussion below), spindle shaped; caudal peduncle slender. Snout moderate, subequals eye, obtuse. Adipose eyelid well developed, especially its posterior part. Maxillary of moderate width, ending under anterior margin of eye; supplemental maxillary moderate. Mouth medium, well inclined, terminal or subsuperior, lower jaw subequal to upper or a little projecting. Teeth small; virtually in one row in jaws, on head and shaft of vomer and on palatines; row on shaft long; in a narrow band on tongue. Shoulder girdle without papillae. Anus placed near first anal spine. Scales small; antedorsal area scaled to

opposite middle or anterior margin of eye; cheek, opercle and interopercle nearly all scaled; fins more or less scaled. (The anterior scales and those on fins are thin and largely missing in most specimens examined, and the preceding statements might need some modification.) Anterior curved part of lateral line moderately rising, rather abruptly continuous with posterior straight part; scales in anterior part 30–37, similar in shape to those in posterior part, transversely expanded to a notable extent, but without a keel and not spinous (the only Gulf species having such scales in anterior part of l.l.), except last 1–3 scales sometimes moderately scute-like; scales in straight part scute-like, keeled and spinous, 31–41; total number of scales in l.l. 66–74; accessory l.l. extending backward to under beginning of soft dorsal. First dorsal rather high, the spines connected by membrane, the anterior ones rather flexible; first spine moderately short, thin; third or fourth spine longest, the two subequal or either one slightly longer than the other; thence rapidly decreasing in length to last. The two disconnected anal spines well developed. Dorsal and anal lobe and fold at base of fins moderate; dorsal having 2–5 more rays than anal. Ventral rather long, reaching to about half the distance from its base to soft anal origin, its outer angle under lower pectoral angle or slightly behind. Pectoral moderately long, reaching over beginning of soft anal origin in large specimens, falling considerably short in smaller fish. Caudal shorter than head.

TABLE XVII

Frequency distribution of the dorsal and anal rays of *Trachurus lathami*.

	dorsal rays						anal rays				
class	28	29	30	31	32	33	26	27	28	29	30
frequency	1	1	13	14	12	4	3	11	20	6	4

Upper part dusky, sometimes with a bluish metallic tinge; lower part light yellowish, golden or silvery; opercle with a marginal spot typically present in the larger specimens, often faint or hardly perceptible; no saliently distinctive color marks.

Gulf specimens examined from off Baffin Bay, Port Aransas and Mustang Island, Texas; off Marsh Island, Mississippi Delta, Breton Sound and Chandeleur Islands, Louisiana; Dauphin Island, Alabama; off Pensacola, Florida. Atlantic coast specimens range from off the coast of Maine to off Melbourne, Florida. The largest specimen examined is 204 mm. (8″), from Woods Hole. The largest Gulf specimen is 180 mm. (7″), from off the Mississippi Delta. This is a pelagic species and is usually not taken in shore seining. The *Pelican* obtained 30 specimens altogether, at 18 stations, with a trawl, in 7–45 fathoms. The species, therefore, apparently also lives at or near the bottom.

TABLE XVIII

Frequency distribution of the total number of scales in the lateral line of *Trachurus lathami*.

	scales								
class	66	67	68	69	70	71	72	73	74
frequency	1	2	2	2	8	11	7	7	7

The frequency distribution of the body depth is given in table 19. The depth was determined at two points. In small specimens the depth averages higher at the ventral base than at the anal origin. In large specimens this relationship is reversed. This difference evidently is a result of a change with growth in the shape of the body. When measured at the anal origin the relative depth increases with growth. At the ventral base the same measurement remains almost stationary, perhaps decreasing slightly with growth.

TABLE XIX

Frequency distribution of body depth in *Trachurus lathami*, measurements taken at two points and segregated by size.

standard length in mm.	distribution 24	25	26	27	28	29	30
			at beginning of anal				
31– 49	1	2	1	1	1	....	....
50– 81	....	8	7	4	....	....	....
92–168	....	....	....	1	8	1	2
			at pelvic base				
31– 49	....	....	2	1	2	1	....
50– 81	....	....	5	10	5	....	....
92–168	....	1	2	3	4	2	....

This species differs from all other Gulf fishes (see also next paragraph), in having the scales in the anterior curved part of the lateral line, as well as those in the posterior part, transversely expanded, with a long tapering wing above and below. They resemble the scales in the posterior part of the lateral line, except that they are neither keeled nor spinous. It is nearest *Selar crumenophthalmus* and differs from that species, besides the structure of the anterior scales, in lacking the two papillae on the shoulder girdle, which are present in the latter species.

Nichols (1940) distinguishes two species of *Trachurus* from the western Atlantic, including the Gulf of Mexico, *lathami* and another species which he identifies with *T. picturatus*, describing the western Atlantic specimens as a new subspecies, *binghami*. He establishes *binghami* on the basis of 54 specimens 12–35 mm. in standard length and one specimen 75 mm., designating the larger specimen as the holotype. According to Nichols *binghami* is more slender than *lathami*, the bend in its lateral line is gentler, the anterior scutes are narrower, and based on an "estimate", it averages a higher number of dorsal rays (32–35) and scutes (76–87). However, Nichols is uncertain whether the holotype is conspecific with the smaller specimens which he examined. Comparing Nichols description with the data given above for *lathami*, we find that the counts of the fin rays and scales of the holotype of *binghami* fall within the range of variation of *lathami*, while the body depth of the type, as well as that of the small specimens, is very close to the range of the latter as given in table 19. Therefore, whatever the status of the smaller specimens examined by Nichols, the holotype of *binghami* might be a variant of *lathami*. If two species of *Trachurus* do exist in the western Atlantic their precise differences still remain to be determined. Among the 28 constituent samples examined by me, comprising 16 specimens from the Gulf and 32 from the Atlantic coast of the United States, I fail to distinguish more than one species of *Trachurus*.

CARANX Lacépède

Caranx Lacépède, Hist. Nat. Poissons 3: 57, 1802 (for a discussion of the status and present use of this name see below)

Spindle shaped, moderately deep; caudal peduncle slender. Snout moderate. Adipose eyelid well developed posteriorly, moderately so anteriorly. Maxillary ending under anterior to posterior margin of eye, moderately broadening posteriorly, wider than pupil; supplemental maxillary of medium width to moderately broad. Mouth medium to rather large, terminal, the jaws subequal or lower jaw slightly projecting. Teeth in a narrow band in upper jaw; in lower jaw virtually in a single row, very few teeth behind outer row directly at symphysis, except in *bartholomaei* in a band; outer teeth in both jaws moderately enlarged; head of vomer with a small patch of teeth, except in *bartholomaei* patch well developed, no backward extension on shaft; palatines and tongue with a band of moderate width or narrow. Anus placed nearer first anal spine than ventral base. Scales small; antedorsal area scaled to a vertical between eye and preopercular margin; a narrow naked strip on midback tapering backward to dorsal origin; cheek and upper part of opercle scaled, larger part of opercle and rest of head naked; fins more or less scaled. Anterior curve in lateral line moderately high, its chord only a little shorter than posterior straight part, except in *crysos;* nearly all or greater part of scales in posterior straight part of l.l. scute-like, notably expanded transversely, heavy, curved, with a longitudinal keel ending in a sharp point directed backward; accessory l.l. extending to opposite posterior margin of head or origin of spinous dorsal. The two dorsal fins well separated in young as well as large specimens; first dorsal rather high (for a carangid), anterior spines rather flexible; normally with 8 spines connected by membrane except last one disconnected and penultimate partly connected; first spine short and slender, third and fourth subequal and longest, last two shortest but stout (in large specimens of *hippos* last 4 spines becoming very short and disconnected); second dorsal with 19–27 segmented rays. The two disconnected anal spines well developed; segmented anal rays 15–24. Dorsal and anal lobe rather high or moderate; fold at base of fins low to high; dorsal having 3–5 rays more than anal. Ventral moderate, reaching about half the distance from its base to soft anal origin, varying a little both ways; its outer angle under lower pectoral angle or slightly more forward. Pectoral strongly falcate, notably long, reaching far beyond soft anal origin. Caudal subequals head, varying a little both ways.

The species of *Caranx* are yellowish or golden, often suffused with a dusky shade on back and fins; without distinctive color marks, except a black spot at posterior margin of opercle present or absent depending on the species and individual variability.

Small specimens of three species, *hippos, latus* and *bartholomaei* are cross banded. Typically with 6–7 black bands against a lighter background, the first band under beginning of spinous dorsal, the last at base of caudal; an oblique band from eye towards origin of dorsal; last band disappearing very early and not sharply marked in the smallest specimens examined.

Small specimens of *crysos* were not examined. Nichols (1938) figures a small specimen of that species, 22 mm. in standard length, as lacking cross bands.

The nearest relatives of *Caranx* among the Gulf carangids, are *Selar, Decapterus* and *Trachurus* and it differs from all three in having the anterior scalation less extensive, in addition to other differences as given in the key and the descriptions. The species of *Caranx* reach a much larger size than those of the other three genera.

Baughman (Copeia, 1947, p. 280) records *Caranx ruber* from Port Isabel, Texas. I have no available specimens from the northern Gulf coast. Three specimens examined, one each from Tortugas, Florida, Cuba and Nassau, Bahamas, have: D VIII; I 27–28. A II; I 24. Pectoral 19–21. Gill rakers 13+32–33. Scales in straight part of lateral line 44–45 of which the last 20–27 are keeled scutes. The depth in the 3 specimens 92, 184 and 245 mm. in standard length is 36, 33 and 30, respectively. Chord subtending arch in lateral line only moderately shorter than straight part. This species then falls in the key here given next to *bartholomaei* differing from that species in having a larger number of gill rakers and averaging a slenderer body.

Nomenclature.—Fowler (1936, p. 692) states that Desmarest (in Chenu and Desmarest, 1874, p. 242) designates *Scomber carangus* Bloch as the genotype of *Caranx*. This conclusion is unacceptable. The following is an abstract of the account by Desmarest giving those statements which are pertinent to our question.

"Cette tribu renferme les espèces dans lesquelles la carène de chaque côté de la queue . . . Le genre principal est celui des CARANX, Cuv., Val., . . . On les subdivise en : 1° SAURELS (*Trachurus*, Cuv., Val.), à forme oblongue . . . à ligne latérale armée, sur toute sa longueur . . . le type est le Maquereau batard de la Manche (*Caranx trachurus*, Lacépède) . . . 2° les CARANX PROPREMENT DITS (*Caranx*, Cuv., Val.), qui, avec la forme des Saurels, n'ont de lames ou de boucliers qu'à la dernière partie, ou partie non soudée de la ligne latérale . . . on a donné la description d'une cinquantaine d'espèces de ce groupe [no type designated] . . . 3° les CAROUGES, Cuv., Val., qui, avec la ligne latérale des *Caranx*, ont une forme plus élevée et surtout plus de saillie au front et à la nuque; groupe nombreux en espèces . . . et dont le type est le Carouge des Antilles (*Scomber carougus* [sic] Bloch) . . . 4° les CISTUTES, G. Cuvier, à deuxième dorsale et anale prolongées en faux [no type designated]."

As may be gathered from the above quotation, Chenu and Desmarest, in the main, give a brief outline of Cuvier and Valenciennes' (1833) classification. They divide the genus Caranx into four subgenera by differences in certain morphological characters. Two of these subgenera, *Trachurus* and *Caranx*, they supply with the Latin names used by Cuvier and Valenciennes. For the other two subgenera, les Carouges and les Cistutes, they use French names only. The latter two names are apparently modifications, intentional or unintentional, of Cuvier and Valenciennes "des carangues" (1833, p. 89) and "les citules" (p. 125). They are evidently used as French common names, not latinized, and have no standing in nomenclature. Furthermore, they designate type species for only two subgenera, *Trachurus* and their les Carouges; but not for *Caranx* and their les Cistutes.

The first definite genotype designation for *Caranx* Lacépède seems to be that of Jordan and Gilbert (1882, p. 433) who designate *Scomber speciosus* Forskal, as its type species. Consequently, the name *Caranx* cannot be used for the four species here assigned to it, according to the Rules, since they are not congeneric with *speciosus*, as carangid genera are now treated. However, these species and their congeners have generally been placed in *Caranx* and this treatment is here continued.

This is a case where adherence to the Rules will cause the greater confusion, and it would be well for the International Commission to use its plenary power and assign *Scomber hippos* Linnaeus, as was done later by Jordan and Gilbert (1883, p. 192), or a similar species, as the genotype of *Caranx* Lacépède. That would leave *Scomber speciosus* Forskal as the genotype of *Gnathanodon* Bleeker by monotypy.

Caranx latus Agassiz

Horse-eye jack

Caranx latus Agassiz in Spix, Selecta genera et species piscium Brasiliensium, p. 105, pl. 56b, fig. 1, 1829 (Brazil).—Jordan and Evermann (in part), Bull. U. S. Nat. Mus. 47(1): 923, 1896 (West Indies to Virginia; west coast of Mexico; Panama; Galapagos Archipelago; the figure published as *latus* representing *bartholomaei*).—Nichols, Bull. Amer. Mus. Nat. Hist. 31: 186, 1912 (Havana market, Cuba).—Meek, Field Mus. Nat. Hist. Pub. 10: 101–134 (Costa Rica in fresh water).—Meek and Hildebrand, Field Mus. Nat. Hist. Pub. (zool. ser.) 15(2): 354, pl. 26, fig. 1, 1925 (Atlantic coast of tropical America; said not to occur in Pacific; young figured).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 223, 1928 (Ocean View, Va.).—Nichols, Amer. Mus. Novit. 967: 3–4, 1937 (young described).—Longley and Hildebrand, Carnegie Inst. Washington Publ. 535: 78 1941 Tortugas, Fla.).—Gunter, Amer. Midl. Nat. 26: 196, 1941 ("reasonably common in Texas offshore waters").—Gunter and Knapp, Texas Jour. Sci. 3: 136, 1951 (Mustang Island, Texas)

Xurel lata Jordan, Evermann and Clark, Rep. U. S. Comm. Fish. 1928 (2): 272, 1930 (listed).—Gunter, Copeia 1935 (1): 40 (Gulf, off Louisiana; Barataria Bay).—Baughman, Trans. Texas Acad. Sci. 24: 22, 1941 (Freeport and Galveston, Texas)

D VIII; I 20–22. A II; I 16–17. P 19–21. Scutes 30–42. GR 14–16.

Dorsal rays modally 21 (in 11), often 20 (4), sometimes 22 (2). Anal rays usually 17 (16), sometimes 16 (1). Pectoral rays modally 20 (10), very often 21 (6), sometimes 19 (1). Gill rakers on upper limb 6–8, upper 3–4 short or tubercle-like in the larger specimens; on lower limb 14–16 with 1–2 tubercles in front or 16–18 altogether; total number of gill rakers and tubercles on both limbs 23–25. Body rather deep, 40–44 in 6 specimens 55–135 mm., 38–41 in 7 specimens 140–270 mm., 34–37 in 4 specimens 277–440 mm. Anterior profile rising steeply and making a rather gradual curve. Maxillary ending under posterior margin of eye or nearly so. Anterior 1–5 scales in straight part of lateral line not definitely scute-like, sometimes all scutes. Dorsal and anal lobe high; fold of skin at their base moderate; the fins moderately scaled (the rays rather easily counted). Spot on opercle faint or absent. Cross bands in young notably wide and the interspaces narrow.

Only two small Gulf specimens, 112–131 mm., examined from Sand Island, Alabama and Laguna Madre, Texas. On the Atlantic coast of the United States from Beaufort, North Carolina to Tortugas, Florida. Also from Nassau, Bahamas; Cuba; Jamaica; Haiti; Puerto Rico; Honduras; Old Providence Island; Curacao; Porto Bello, Panama; Gulf of Venezuela; Bahia, Brazil. The largest specimen is 440 mm. (17″) from Key West.

This species is nearest structurally to *hippos* and differs in having the chest scaled and in the better developed folds encasing the dorsal and anal. The two species differ in the averages of the fin ray and scute counts, but they overlap widely in these characters. The gill raker count is nearly the same in both. Specimens as small as 45 mm. have the chest scaled for its greater part. No attempt was made to distinguish smaller specimens. It is to be expected that small specimens of *latus* in which the scales on the chest have not yet developed, will be difficult to distinguish from *hippos*.

Caranx hippos (Linnaeus)

Common jack, Plate 5, fig. c

Scomber hippos Linnaeus, Syst. Nat., ed. 12, p. 494, 1766 (Charleston, South Carolina)

Caranx hippos Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 920, pl. 141, fig. 387, 1896 ("warm seas, generally abundant").—Meek and Hildebrand, Publ. Field Mus. Nat. Hist. Chicago (zool. ser.) 15(2): 350, 1925 (Panama, both coasts).—Bigelow and Welsh, Bull. U. S. Bur. Fish. 40(1): 233, fig. 108, 1925 (Lynn Beach, Massachusetts Bay).—Nichols and Breder, Zoologica 9: 112, fig. 151, 1927 (Woods Hole, Mass.; New York).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 221, fig. 129, 1928 (Chesapeake Bay).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2): 696, fig. 312, 1936 ("tropical seas"; young figured).—Gunter, Louisiana Conservation Review 5: 23, 1936 (obtained in shrimp trawls).—Nichols, Amer. Mus. Novit. 976:1, 1937 (young described).—Gunter, Ecol. Mon. 8: 334, 1938 (Louisiana, "Very often the small fish were taken from the bell of the jellyfish, *Stomolophus* sp. Adult fish were common in the summer three or four miles offshore.").—Nichols, Bull. Bingham Ocean. Coll. 7(2): 7, 1939 (young described.)—Baughman, Trans. Texas Acad. Sci. 24:22, 1941 ("common on the Texas coast").—Gunter, Amer. Midl. Nat. 28(2): 311, 1942 (young in fresh water in Florida; listed as euryhalin).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1): 57 and passim, 1945 (Texas, Louisiana; life history notes) D VIII; I 19–21. A II; I 15–17. P 20–21. Scutes 24–39. GR 14–15.

Dorsal rays modally 20 (in 14), often 21 (3) or 19 (2). Anal rays modally 16 (13), often 17 (5), sometimes 15 (1). Pectoral rays 20 (9) or 21 (10). Gill rakers on upper limb 7–8, the inner 3–5 in large specimens rather abruptly shorter or tubercle-like; on lower limb 14–15 with 2–3 tubercles; total number of gill rakers and tubercles on both limbs 23–26. Body rather deep, 40–44 in 5 specimens 70–140 mm., 38–42 in 10 specimens 155–285 mm., 33–34 in 3 specimens 315–445 mm., 29 in 1 specimen 747 mm.; anterior profile rather characteristic, rising very steeply and making a strongly convex curve. Maxillary ending under posterior margin of eye or nearly so. A rather large area in front of ventral base and below pectoral base scaleless (the only Gulf species of *Caranx* having this character), except a small patch of scales on ventral aspect, directly in front of ventral base. Anterior 3–10 scales in straight part of lateral line not definitely scutelike. Dorsal and anal lobe high; fold of skin at their base low; the fins moderately scaled for a short distance anteriorly, scaleless in greater part (the rays easily counted).

In 18 specimens 70–444 mm. spinous dorsal as described under the genus; in one specimen 747 mm. last four spines very short, nearly disconnected, the last 2 being hidden under the skin.

Spot at posterior edge of opercle usually well developed. The smaller specimens often with a large black spot on pectoral near its lower posterior margin, developed an interradial membrane, not extending on rays; and an inner black spot at upper pectoral angle. Cross bands in young 6, subequal to or moderately wider than interspaces. The anterior 5 cross bands persist in specimens up to 100 mm. or somewhat larger, becoming faint before they disappear. The oblique band on the nape disappears earlier.

Gulf specimens examined from: Clearwater Bay and Pensacola, Florida; Mississippi; Bayou St. Denis, Tambour Bay, Bay la Mer, Barataria Bay, Grand Isle and Isle

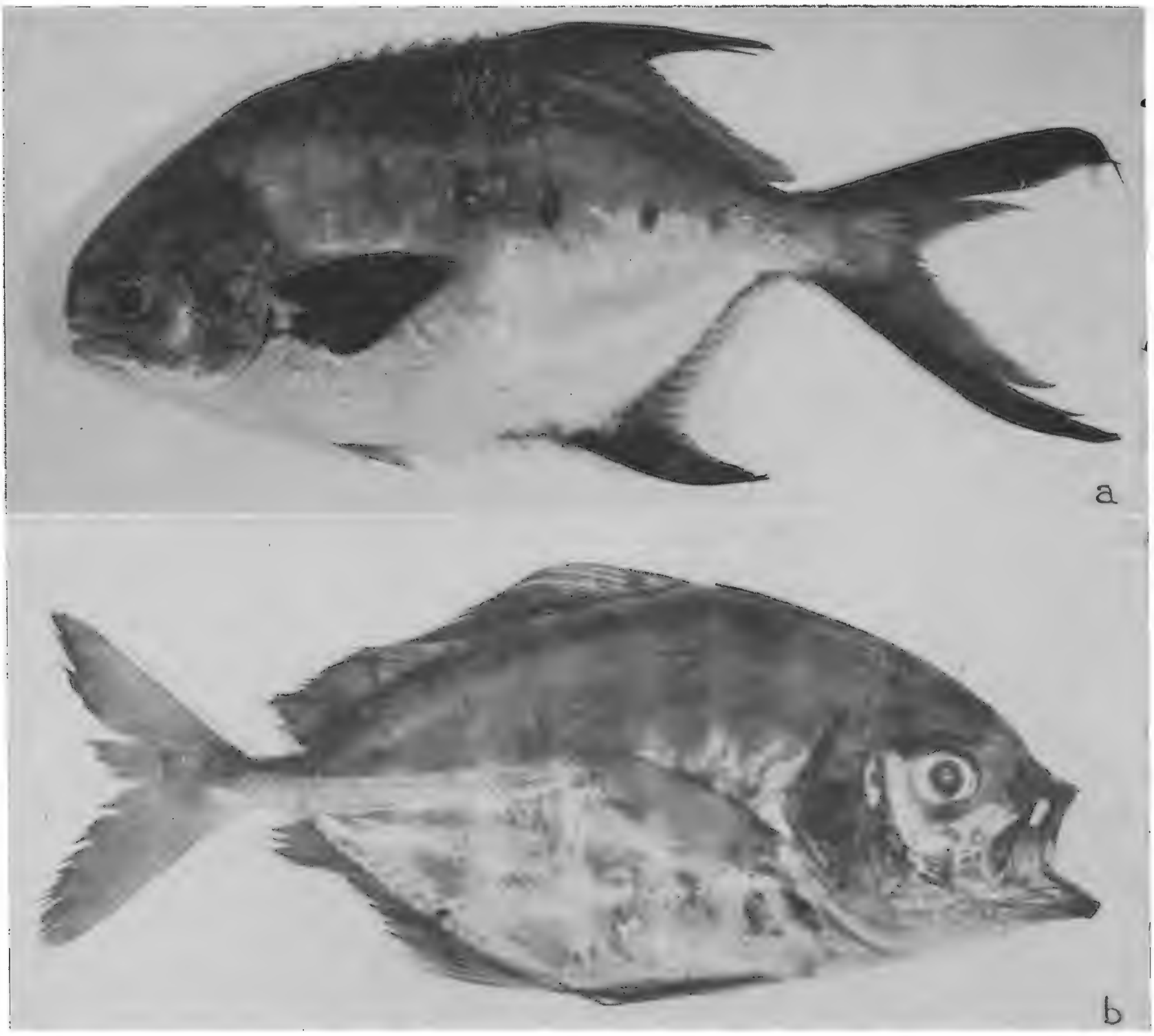

PLATE 5

Fig. a. *Trachinotus marginatus*, 320 mm Uruguay. USNM 87728.
Fig. b. *Uraspis heidi*, 207 mm Off Mississippi Delta. USNM 157566.

Dernière, Louisiana; Galveston, Matagorda Bay, Corpus Christi, Laguna Madre and Brazos Santiago, Texas. On Atlantic coast of the United States from Woods Hole, Massachusetts to Key West, Florida. Also, from Gulf of Campeche; Cuba; Puerto Rico; Curacao; Atlantic coast of Panama and Colombia; Gulf of Venezuela. The largest specimen is 747 mm. (29″) from Pensacola. This common species reaches to a considerably larger size.

This species differs from the others in lacking scales on the chest. Structurally it is nearest to *latus* and the differences between them are discussed under the account of that species.

Caranx bartholomaei Cuvier and Valenciennes

Yellow jack

Caranx bartholomaei Cuvier and Valenciennes, Nat. Hist. Poiss. 9: 100, 1833 (Saint Bartholomew Island).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 919, 1896 ("West Indies, occasionally northward to Florida and North Carolina").—

PLATE 5—(Continued)

Fig. c. *Caranx hippos*, 305 mm Woods Hole, Mass. USNM 12681.
Fig. d. *Caranx crysos*, 295 mm Indian Key, Fla. USNM 57224.

Meek and Hildebrand, Publ, Field Mus. Nat. Hist. Chicago (zool. ser.) 15 (2): 351, 1925 (Atlantic coast of Panama).—Nichols and Breder, Zoologica 9: 111, fig. 150, 1927 (Woods Hole).—Nichols, Bull. Bingham Ocean. Coll. 7(2): 3, 1939 (young described).—Longley and Hildebrand, Carnegie Inst. Washington Publ. 535: 78, 1941 (Tortugas, Florida).—Gunter and Knapp, Texas Jour. Sci. 3: 136, 1951 (St. Joseph Island, Texas)

Caranx latus Jordan and Evermann (in part), Bull. U. S. Nat. Mus., no. 47, pt. 4, pl. 142, fig. 389, 1900 (the figure, published as *latus*, representing this species)

D VIII; I 25–27. A II; I 22–24. P 20–21. Scutes 20–31. GR 17–21.

Dorsal rays modally 26 (in 7), often 27 (2) or 25 (1). Anal rays modally 23 (7), often 22 (2) or 24 (1). Pectoral rays predominantly 21 (6), often 20 (3). Gill rakers on upper limb 7–9, upper 3–4 abruptly shorter or tubercle-like in large specimens; on lower limb 17–21 with 1–2 tubercles, or 19–21 altogether; total number of gill rakers and tubercles on both limbs 26–30. Body rather deep, 46–49 in 3 specimens 32–80 mm., 39–42 in 6 specimens 85–165 mm., 33 in 2 specimens 270–355 mm.; anterior profile rising moderately. Maxillary ending under anterior margin of eye. Lower jaw with a narrow band of teeth in front becoming a single row posteriorly; patch of teeth on head of vomer well developed (in other three species here treated teeth in lower jaw virtually in a single series, patch on vomer small). Scutes confined to posterior portion of straight part of lateral line, anterior 12–19 scales not definitely scute like. Dorsal and anal lobe and fold of skin at their base moderate; these fins very densely scaled (the rays counted with difficulty).

No opercular spot in the specimens examined. One small specimen, 30 mm. in standard length from Tortugas, has the cross bands faint, subequal to the interspaces, and 7 in number, instead of 6 as in *hippos* and *latus*. The oblique band behind the eye is represented by a mere trace. The characteristic banded color pattern of the young of *Caranx* possibly disappears early in this species.

Only one small Gulf specimen, 85 mm., examined from Pensacola, Florida. Also, from Woods Hole, Massachusetts; Beaufort, North Carolina; Tortugas, Florida; Nassau, Bahamas; Cuba; Jamaica; Porto Bello, Panama. The largest specimen is 355 mm. (14″) from Nassau.

This species differs from its other three congeners here treated in having a higher dorsal and anal count, a greater extent of dentition on the lower jaw and vomer, and in that a considerable extent of the straight part of the lateral line, anteriorly, has ordinary scales, instead of scutes. In the latter character it most nearly approaches *hippos*.

Caranx crysos (Mitchill)

Blue runner, Plate 5, fig. d

Scomber crysos Mitchill, Trans. Lit. Philos. Soc. New York 1:424, pl. 4, fig. 2, 1815 (New York)

Caranx crysos Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 921, pl. 142, fig. 388, 1896 (Cape Cod to Brazil).—Meek and Hildebrand, Publ. Field Mus. Nat. Hist. Chicago (zool. ser.) 15(2): 358, pl. 27, 1925 (Atlantic coast of Panama).—Bigelow and Welsh, Bull. U. S. Bur. Fish. 40 (1): 234, fig. 109, 1925 ("Brazil to Cape Cod").—Nichols and Breder, Zoologica 9: 113, fig. 152, 1927 (Woods Hole, Mass.; New York).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 222, fig.

130, 1928 (Chesapeake Bay).—Nichols, Amer. Mus. Novit. 1014: 1, fig. 1, 1938 (account of young).—Nichols, Bull. Bingham Ocean. Coll. 7(2): 4, 1939 (description of young).—Longley and Hildebrand, Carnegie Inst. Washington Publ. 535: 79, 1941 (Tortugas, Florida)

Paratractus crysos Jordan, Evermann and Clark, Rep. U. S. Comm. Fish. 1928 (2): 272, 1930 (listed).—Gunter, Copeia 1935 (1): 40 (Louisiana; young taken from the bell of *Stomolophus*).—Baughman, Trans. Texas Acad. Sci. 24: 22, 1945 (Port Arthur, Galveston and Freeport, Texas)

D VIII; I 23–24. A II; I 19–21. P 21–23. Scutes 45–54. GR 25–28.

Dorsal rays modally 23 (12), often 24 (4). Anal rays modally 20 (9), very often 19 (7), sometimes 21 (1). Pectoral rays with the mode decidedly at 22 (12), often 21 (2) or 23 (4). Gill rakers 12–14+25–28, sometimes an additional tubercle at either end of the gill arch; total number of gill rakers and tubercles on both limbs 38–42. Body rather slender, 30–36 in 13 specimens 100–295 mm., 29 in 1 specimen 550 mm.; anterior profile rising moderately. Maxillary ending approximately under middle of eye. Anterior curve in lateral line relatively short (as compared with its 3 Gulf congeners), its chord about one and three quarters times in straight part of l.l.; all scales in straight part of l.l., except sometimes anterior 1–2, scute-like. Dorsal and anal lobe moderately high; fold at their base well developed, almost entirely encasing low part of fins; these fins densely scaled (the rays counted with difficulty). Spot on opercle usually moderately developed, sometimes faint.

Only three Gulf specimens examined, from Grand Isle, Louisiana and Pensacola, Florida. On the Atlantic coast from Halifax, Nova Scotia to Key West, Florida. Also from Nassau, Bahamas; Cuba; Jamaica; Puerto Rico; Atlantic coasts of Panama and Colombia; Gulf of Venezuela; Brazil. The largest specimen is 550 mm. (22″) from Woods Hole. The largest Gulf specimen is 465 mm. (18″) from Pensacola.

This species differs from its 3 Gulf congeners in having a greater number of gill rakers, a more slender body, a greater average number of pectoral rays and a shorter anterior curve in the lateral line. Concomitant with the latter character it has a larger number of scutes.

HEMICARANX Bleeker

Hemicaranx Bleeker, Versl. Med. Kon. Akad. Wet. Nat. Amsterdam 14: 135, 1862 (genotype *Caranx marginatus* Bleeker by original designation)

This genus is near *Caranx* differing in having a less extensive dentition, a deeper body and narrower maxillary. It is also close to *Chloroscombrus* and *Uraspis* as discussed under their accounts.

Nomenclature.—Fowler, in the references cited under the species and in other places, uses the generic name *Alepes*, instead of *Hemicaranx*, for this species. The genotype of *Alepes* Swainson is the wori parah of Russell which formed the basis of Swainson's *Alepes melanoptera*. Fowler states that Russell's species is the same as *Caranx nigripinnis* Day; but Day (1876, p. 225) is uncertain about this identification as he places, in his synonymy of *nigripinnis*, the citation to Russell with a query. Consequently, the status of *Alepes*, as that of its genotype, is in doubt. Now, assuming that Russell's wori parah is the same as Day's *C. nigripinnis* and comparing the latter with our species, Day's figure shows a more elongate fish with a broader maxillary and a higher

first dorsal fin. Also, Day describes his *C. nigripinnis* as not having a sheath on the dorsal and anal fins, differing in this respect from our species. All these differences might mean that the two species compared are not congeneric. Therefore, judged by the available evidence, *Alepes melanoptera* Swainson, the type species of its genus, is either unidentifiable at the present time, or else it is generically different from our species. Under these circumstances, to introduce a change in the widely used name of a species on the basis of what must now be regarded as a mere conjecture, does not seem conducive to nomenclatorial stability. Therefore, the more commonly used generic name *Hemicaranx* is here employed to form the name of our species.

Hemicaranx amblyrhynchus (Cuvier and Valenciennes)

Caranx amblyrhynchus Cuvier and Valenciennes, Hist. Nat. Poiss. 9: 100, pl. 248, 1833 (Brazil)

Hemicaranx amblyrhynchus Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1) : 912, pl. 141, fig. 386, 1896 (Cape Hatteras to Brazil).—Nichols, Amer. Mus. Novit. 967: 5, 1937 (South Carolina; Florida; young described; suggests that *rhomboides* based on young specimens of *amblyrhynchus*).—Baughman, Copeia 1947(4) : 280 (Aransas Bay, Texas).—Baughman, Texas Jour. Sci. 2: 245, 1950 (Galveston and Rockport, Texas)

Hemicaranx rhomboides Meek and Hildebrand, Publ. Field Mus. Nat. Hist. (zool. ser.) 15(2) :345 pl. 25, fig. 2, 1925 (Fox Bay, Panama; type reexamined).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1) : 57, 1945 (Aransas Bay, Texas)

Alepes amblyrhynchus Fowler, Proc. Acad. Nat. Sci. Philadelphia 1905: 71 (Rio de Janeiro).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2) : 690, fig. 310, 1936 (Rio de Janeiro, synonymy)

D VII (VIII) ; I 27–29. A II; I 23–25. P 19–22. Scutes 45–54. GR 19–23.

Dorsal spines usually 7 (in 11), sometimes 8 (1). Dorsal rays modally 28 (7), very often 29 (3) or 27 (2). Anal rays modally 24 (6), very often 25 (4) or 23 (2). Pectoral rays modally 21 (6), often 20 (2), 22 (1) or 19 (1). Gill rakers 8–10+19–23, sometimes an additional tubercle at end of upper limb; total number of gill rakers and tubercles on both limbs 28–33. Body deep, 49–53 in 5 specimens 40–80 mm., 44–48 in 2 specimens 125–145 mm., 40–42 in 5 specimens 150–325 mm., well compressed; upper profile rising steeply but gradually; caudal peduncle slender. Snout short, obtuse. Adipose eyelid moderately developed. Maxillary short and narrow, ending under anterior margin of pupil, its widest part less than pupil diameter; supplemental maxillary narrow. Mouth small, terminal. Teeth small, in a single row in both jaws; vomer with many tiny papillae, without teeth; palatines and tongue with a patch of teeth posteriorly (patch of palatine teeth variable in extent, apparently often appearing late in life as a few small and medium sized specimens examined lacking palatine teeth). Anus placed about halfway between first anal spine and ventral base. Scales small, antedorsal area scaled to opposite preopercular margin; a naked strip on midback tapering to dorsal origin; area between eye and preopercular margin and a small area on upper part of opercle scaled, greater part of opercle and cheek and rest of head naked; chest scaled. Caudal scaled, other fins scaleless. Anterior curved part of lateral line rather high and short, its chord about two and a half times in posterior straight part; usually all scales in posterior part scute-like, often 1–4 normal scales at its anterior end; accessory 1.1. reaching nearly

to dorsal origin. First dorsal moderate in height, anterior spines rather flexible, connected by membrane except last one; usually with 7 spines; first spine short, third or fourth longest, the two subequal or either one slightly longer, thence rapidly decreasing in length. The two disconnected anal spines moderate. Dorsal and anal lobe very moderately raised in large specimens; fold at their base well developed, sheathing nearly entire fin except distal part of lobe; dorsal having 3–5 rays more than anal. Ventral short in large specimens, extending less than half the distance from its base to soft anal origin; its outer angle below lower pectoral angle or a little behind. Pectoral falcate, long, reaching beyond beginning of soft anal. Caudal longer than head. Golden yellow without distinctive marking, except a black spot on opercle.

Small specimens with 4 dark cross bands, the first under origin of spinous dorsal, the last at a moderate distance in front of end of soft dorsal; the bands slightly narrower than or subequal to interspaces; a cross band on nape less well marked, terminating in a large spot on opercle. Specimens 22 mm. or less are almost uniformly pigmented. The bands are very faint in one 30 mm. specimen. They are well or sharply marked between 35 and 100 mm. They become faint at 125 mm. and are altogether absent at 145 mm. or larger.

Gulf specimens examined from Corpus Christi Bay, Harbor Island, Aransas Pass, Aransas Bay and Galveston, Texas; off Tigre Point, Grand Isle, Barataria Bay and Breton Island, Louisiana; off Gulfport, Mississippi; Pensacola, Florida. Also, off Bull Bay and Charleston, South Carolina; off New Smyrna, Florida; Fox Bay, Colon, Panama (holotype of *H. rhomboides*); Pernambuco, Brazil. The largest specimen is 325 mm. (14″) from Charleston. The largest Gulf specimen is 280 mm (11″) from Pensacola.

Among the Gulf carangids, this species is nearest *Uraspis heidi* and the differences between them are discussed under the account of that species.

H. rhomboides Meek and Hildebrand was separated from *amblyrhynchus* on the basis of the low dorsal and anal fins; but this is an age character in this as well as many other carangid species. The holotype of *rhomboides* agrees with specimens of *amblyrhynchus* of like size, in the height of the fins as well as in other characters.

URASPIS Bleeker

Uraspis Bleeker, Nat. Tijdschr. Ned. Ind. 8:418, 1855 (genotype *Uraspis carangoides* Bleeker by monotypy)

This genus differs from the other carangid genera here treated in having the spinous point of most of the scutes directed forward and the presence of milky white areas in the mouth cavity. Its relationship is discussed further under the account of the species.

Uraspis heidi Fowler

Plate 5, fig. b

Uraspis heidi Fowler, Proc. Acad. Nat. Sci. Philadelphia 90: 150, 1939 (New Jersey)
D VIII; I 29. A 0; I 21. P 23. Scutes 38. GR 14.

Body deep, compressed; contour of back a rather steep, well marked, nearly symmetrical curve from snout to caudal peduncle; lower profile a nearly straight, descending line to anal origin, thence a nearly straight, rather steep line rising to

peduncle; caudal peduncle rather slender, subterete (excluding the well developed ridge formed by the scutes). Snout short, obtuse, moderately longer than eye (measured between margins of eyelid). Adipose eyelid moderately developed. Maxillary short, ending under anterior margin of eye, of moderate width, its widest part somewhat wider than pupil; supplemental maxillary moderate. Mouth small; subsuperior, lower jaw moderately projecting, inclined nearly at a 45° angle. Teeth moderately small, in two rows in both jaws, those at symphysis of upper jaw and inner teeth of lower jaw moderately larger than others; no teeth on vomer, palatines and tongue. Gill rakers rather well developed, 6+14. Anus placed about halfway between pelvic base and soft anal origin. Scales small; body all scaled, antedorsal area in large part scaled, the scalation on back extending to an irregular, somewhat transverse line opposite preopercular margin; chest, in front of a nearly vertical line through pelvic base scaleless; area between eye and preopercle scaled, the scalation continued for some distance downward on cheek, an area on upper part of opercle and preopercle scaled, the scalation continuous with that on cheek; rest of head, including snout, interorbital and a strip along midback to dorsal origin scaleless. Caudal partly scaled, other fins scaleless. Anterior curve in l.l. comparatively long and low, its chord about five-sevenths the length of the straight part; all scales, except first one, in straight part scute-like, the spinous point of the posterior and greater number of scutes directed forward (the only Gulf carangid having this peculiarity); a few of the anterior scutes having weak points directed backward, the spinous points increasing gradually in strength and changing gradually in direction; accessory l.l. about reaching to opposite dorsal origin. First dorsal low, the first four spines unevenly graduated, the fourth longest, thence rapidly decreasing in length, first spine very short, third moderately shorter than fourth; the spines flexible and connected by membrane, except last one partly disconnected, very short, stout and pungent. The two disconnected anal spines virtually absent in specimen examined, a mere trace of their points hidden under the skin, faintly appreciable with the point of a needle as slight irregularities in the trenchant mid-ventral line. Anterior spine of second dorsal and anal flexible; the two fins, especially the dorsal rather high, the rays very moderately and gradually decreasing in length backward, the anterior rays not forming a definite projecting lobe; fold at their base slightly developed anteriorly, absent posteriorly; dorsal having 8 more rays than anal. Ventral long, tapering, reaching a moderate distance behind anal origin, its outer angle slightly in front of lower pectoral angle. Pectoral slightly falcate, of medium length, reaching to end of curve in l.l. Caudal a little shorter than head.

Depth 47, head 32, pelvic 33, pectoral 31.

Tongue milky white, the white color tapering backward along bases of gill arches; palate with a similar white, wedge shaped area tapering backward, the head of the wedge expanded sideways; frenum behind upper and lower jaw with a median hyaline area, flanked on each side with a milky white tapering area, in contrast to milky white color rest of mouth cavity largely black; ground color yellowish on upper half, silvery below; a faint trace of 6 dusky cross bands on body, the bands wider than the interspaces; opercle rather dark, without a definite black spot; fins dusky.

The above account is based on one specimen 207 mm.; taken by the "Oregon" off the Mississippi Delta in 32 fathoms, September 24, 1950.

Among the Gulf carangids this species is nearest *Hemicaranx amblyrhynchus*. It differs from the latter as well as all other Gulf carangids in that the spinous point on most scutes is directed forward, instead of backward, and in having milky white areas inside the mouth cavity. It further differs from *H. amblyrhynchus* in having a notably longer ventral, a lower first dorsal, a somewhat wider maxillary, a longer arch in the lateral line, two rows of teeth in the jaws, in lacking teeth on the tongue and palatines, and in having fewer gill rakers, scutes and anal rays, and more pectoral rays.

The type specimen of *U. heidi* was not examined, but the specimen described above substantially agrees with the original description of *heidi*. This species is very near *U. carangoides* Bleeker from the East Indies (see Wakiya, 1924, p. 207), and the precise differences between them remain to be elaborated by the direct comparison of specimens.

CHLOROSCOMBRUS Girard

Chloroscombrus Girard, Proc. Acad. Nat. Sci. Philadelphia 10: 168, 1858 (genotype *Scomber chrysurus* Linnaeus by monotypy, the two species included, *Seriola cosmopolita* Cuv. and Val. and *Chloroscombrus caribbaeus* Girard being synonyms of *Scomber chrysurus* Linnaeus)

This genus is nearest *Hemicaranx* in its characters, form and general appearance. It differs in virtually lacking scutes, in its more extensive dentition and in having the curvature of the ventral contour appreciably better developed than that of the dorsal contour.

Chloroscombrus chrysurus (Linnaeus)

Bumper

Scomber chrysurus Linnaeus, Syst. Nat., ed. 12, p. 494, 1766 (Carolina)

Chloroscombrus caribbaeus Girard, Proc. Ac. Nat. Sci. Philadelphia 10: 168, 1858 (St. Joseph's Island, Texas).—Girard, U. S. and Mex. Bound. Survey, Ichthyology, p. 21, pl. 11, fig. 6, 1859 (St. Joseph's Island, Texas)

Chloroscombrus chrysurus Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 938, pl. 145, fig. 394, 1896 (Cape Cod to Brazil).—Nichols, Bull. Amer. Mus. Nat. Hist. 31: 186, 1912 ("Common in Havana market.").—Nichols and Breder, Zoologica 9: 115, fig. 156, 1926 (Orient, New York).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2): 712, 1936 ("Tropical Atlantic").—Gunter, Louisiana Conservation Review 5: 23, 1937 (catch in shrimp trawls on Louisiana coast).—Gunter, Ecol. Mon. 8: 335, 1938 (Louisiana).—Baughman, Trans. Texas Acad. Sci. 24: 23, 1941 ("Very common on the Texas coast").—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1): 59, and passim, 1945 (Texas; life history notes).—Baughman, Texas Jour. Sci. 2: 246, 1950 (Texas: "The young are found beneath *Stomolophus*.")

D VIII; I 26–28. A II; I 25–27. P 19–20. GR 31–35.

Dorsal rays modally 27 (9), very often 28 (4), often 26 (2). Anal rays usually 27 (7) or 26 (6), often 25 (2). Dorsal spines constant (14). Pectoral rays predominantly 19 (10), very often 20 (4). Gill rakers rather long, 9–11+31–35; total number on both limbs 40–45. Body deep, depth 49–54 in 2 specimens 32–36 mm., 38–45 in 10 specimens 150–305 mm.; well compressed, dorsal and ventral outline

rather trenchant, evenly rounded; curvature of ventral profile greater than that of dorsal to a notable extent; caudal peduncle slender. Snout short, somewhat shorter than eye, obtuse. Adipose eyelid rather well developed posteriorly, very moderate anteriorly. Maxillary moderately broad, ending under anterior margin of eye; supplemental maxillary moderate. Mouth small, more inclined to the vertical than the horizontal, superior, lower jaw projecting. Teeth very small, in narrow bands in jaws and on palatines, except in two irregular rows on side of lower jaw; in a medium patch on head of vomer, none on shaft; teeth on tongue covering its greater part, leaving a narrow, marginal, smooth strip. Anus placed a little nearer first anal spine than ventral base. Scales small; antedorsal area scaled to a vertical between eye and preopercular margin; area between eye and preopercle, and upper part of opercle scaled; greater part of cheek and opercle and rest of head scaleless; caudal and pectoral near their base and dorsal and anal lobes moderately scaled, fins otherwise scaleless. Anterior curve in lateral line moderately high, its chord about one and one-half in straight part; 61–68 scales in straight part of l.l.; scutes rudimentary, not larger than adjacent unmodified scales, keel and blunt spinous point slightly or hardly developed, few, 7–12, confined to caudal peduncle for a variable distance along its middle; accessory l.l. reaching to under beginning of first dorsal. Spinous dorsal moderate in height, spines connected by membrane, except last spine partly or wholly disconnected; anterior spines rather flexible; first spine short and thin; fourth spine longest, third subequal to it or slightly shorter; thence gradually decreasing to last. The two disconnected anal spines fairly developed. Dorsal and anal lobe very moderate; fold at base of fins rather well developed; dorsal usually having one more ray than anal, often the same number in both fins. Ventral fitting in a well developed groove anteriorly, of moderate length, extending less than half the distance from its base to soft anal origin, its outer angle a little behind a vertical through lower pectoral angle. Pectoral notably long and falcate, reaching well beyond a vertical through origin of soft anal. Caudal longer than head.

Upper part, above a horizontal line through upper margin of eye, dark; below that line light silvery or golden, the contrast between the two shades usually abrupt and striking; a black spot at base of caudal, on upper half, partly on peduncle and partly on fin; posterior margin of opercle usually with a black spot, often faint.

This is a common species taken both in surf seining and in trawling in the open Gulf. Gulf specimens examined are from off Mustang Island, Corpus Christi Bay, Harbor Island, off Aransas Pass, Matagorda Bay and Galveston, Texas; off Marsh Island, Isle Derniere, off Caminada Pass, Grand Isle, Barataria Bay, off Grand Terre, off Bay La Mer, and Breton Island, Louisiana; Dauphin Island, Alabama; Pensacola, Apalachicola Bay, Clearwater Bay, and Boca Grande, Florida. On the Atlantic coast of the United States, from Gravesend Beach, New York to Soldier Key, Florida. Also, from Jamaica; Haiti; Puerto Rico; Antigua, British West Indies; Fort Sherman, Canal Zone; Gulf of Venezuela; Brazil. The largest specimen is 305 mm. (12″) from Brazil. The largest Gulf specimen is 194 mm. (8″) from off Barataria Bay.

The shape of the body—notably compressed with the curvature of the ventral outline greater than that of the dorsal and both outlines evenly rounded—together with the black spot on the caudal peduncle, constitute two features by which this species is readily recognized both in the field and the laboratory. Its relationship is discussed above under the genus.

ALECTIS Rafinesque

Gallus Lacépède, Hist. Nat. Poiss. 4: 583, 1802 (genotype *Gallus virescens* Lacépède by monotypy; preoccupied by *Gallus* Moehring 1758)

Alectis Rafinesque, Analyse de la Nature, p. 84, 1915 (substitute for *Gallus* Lacépède)

Blepharis Cuvier, Regne Animal, t. 2, p. 322, 1817 (genotype *Zeus ciliaris* Bloch by monotypy)

Scyris Cuvier, ibid., ed. 2, t. 2, p. 209, 1829 (genotype *Gallus alexandrinus* Geoffroy by monotypy)

Gallichthys Cuvier and Valenciennes, Hist. Nat. Poiss. 9: 168, 1933 (three species included, *major*, *chevola* and *aegypticus*; no type designated)

Hynnis Cuvier and Valenciennes, ibid., p. 195 (genotype *Hynnis goreensis* Cuvier and Valenciennes by monotypy)

Blepharichthys Gill, Proc. Acad. Nat. Sci. Philadelphia 14: 436, 1862 (substitute for *Blepharis* Cuvier preoccupied in botany)

Gallichthys Lutken, Spolia Atlantica, p. 604, 1880 (*Blepharis, Scyris* and *Hynnis* placed in synonymy)

Alectis Nichols, Bull. Amer. Mus. Nat. Hist. 42(4): 285, 1920 (account of specimens in American Museum of Natural History)

In the presence of well developed scutes *Alectis* is near *Caranx*. In the extent of scalation it is near *Vomer*. In its body shape and position of the anus, it is intermediate between those two genera. In the development of the first dorsal it is more extreme than *Vomer*. Another specialized feature is the long dorsal and anal filaments. The most plausible explanation seems to be that *Vomer* and *Alectis* represent two independent lines of descent from *Caranx* or a similar genus.

Nomenclature and synonymy.—Fowler (1936) applies the later name *Blepharis* for this genus, stating that: "The type of *Alectis* Rafinesque is virtually *Zeus gallus* Linne." He consequently places *Alectis* in the synonymy of *Selene* Lacépède. As the type of *Alectis* is unquestionably *Gallus virescens* Lacépède, Fowler evidently assumes that *Zeus gallus* Linnaeus and *Gallus virescens* Lacépède refer to the same species. However, this assumption is not in accord with the facts in the case. While Lacépède does place *Zeus gallus* Linnaeus in the synonymy of his *Gallus virescens*, the accounts of these two authors do not at all agree. They evidently refer to two distinct species. Neither account is adequate according to present day standards, but Linnaeus' description of his *Zeus gallus* and Lacépède's account of his *Gallus virescens* more nearly agree with the species here designated as *Selene vomer* and *Alectis crinitus*, respectively. It is evident that Lacépède based his species on certain specimens which he described, some of which at least belonged to *Zeus crinitus* Mitchill or some other species congeneric with it; but his synonymy is partly in error.

A cursory examination of specimens in the National Museum, in a graded size range, from West Africa, the Philippines, the East Indies, Hawaii and the eastern Pacific, in addition to the western Atlantic specimens, leads me to conclude that the above synonymy, as previously determined by Lutken and by Nichols, is acceptable in that the proposed generic names largely represent growth stages of congeneric species which undergo extraordinary changes in the form of the body, head and fins as they increase in size. The species belonging to this genus still remain to be properly determined and distinguished. Because of the very extensive growth changes, it would take adequate samples in graded size ranges to distinguish the species properly at all

stages of development. According to our present knowledge only one properly authenticated species exists in the western Atlantic.

Alectis crinitus (Mitchill)

African pompano; threadfish (young), Plate 6, figs. a–c

Zeus crinitus Mitchill, Amer. Jour. Sci. Arts 11: 144, fig., 1826 (Shoreham, N.Y.)

Gallichthys crinitus Lutken, Spolia Atlantica, p. 539 and passim, 1880 (discussion of growth changes, relation to other species and synonymy)

Alectis ciliaris Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 931, 1896 ("Tropical America on both coasts north to Cape Cod and Mazatlan").—Nichols, Amer. Mus. Nat. Hist. 42: 286, 1920 (specimens from New York, North Carolina and Japan compared).—Meek and Hildebrand, Publ. Field Mus. Nat. Hist. (zool. ser.) 15(2): 364, 1925 (Atlantic and Pacific coasts of Panama; Virginia; Florida; Hawaii; New South Wales).—Nichols and Breder, Zoologica 9: 113, fig. 153, 1927 (Woods Hole; Orient, Long Island; New York)

Hynnis cubensis Poey, Mem. Hist. Nat. Cuba 2: 235, 1860 (Cuba).—Nichols, Bull. Amer. Mus. Nat. Hist. 42: 289, pl. 19, 1920 (Florida, based on a large mounted specimen)

Alectis indicus Nichols (in part), ibid., p. 292 (concludes that *cubensis* is a synonym of *indicus*)

Blepharis crinitus Fowler, Amer. Mus. Nat. Hist. 70(2): 703, fig. 314, 1936 ("Tropical Atlantic")

D (VII) 0; I 18–19. A (II) 0; I 15–16. P 18–20. GR 14–16.

Dorsal rays predominantly 19 (9) very often 18 (5). Anal rays predominantly 16 (11), often 15 (2). Pectoral rays predominantly 19 (10), often 18 (1) or 20 (1). Gill rakers on upper limb 5–6, 2–3 at end becoming very short or tubercle-like in large specimens; on lower limb 14–16, often with one or two tubercles in front; total number of gill rakers and tubercles on both limbs 19–23. Exceedingly deep in young, becoming oblong with growth (see below); compressed, dorsal and ventral profiles moderately trenchant, except anterior part of head; in the smaller specimens dorsal profile rising very steeply from snout to beginning of soft dorsal, head part of outline moderately rounded, a nearly straight steep line behind head; with growth dorsal profile changing markedly, in large specimens contour of back in front of soft dorsal, to an area over eye, a nearly straight line diverging but moderately from a horizontal (approaching outline of *Vomer* and *Selene*); lower profile well rounded to anal origin; profile at base of dorsal and anal a nearly straight line, the two lines nearly equally inclined. Snout and preorbital moderately long. Adipose eyelid very moderately developed. Maxillary medium, ending approximately under anterior margin of pupil. Mouth of medium extent, well inclined, subsuperior, the lower jaw moderately projecting. Teeth small, in a band at symphysis of jaws, tapering backward, sparse on head of vomer and palatines, none on shaft of vomer; a fairly wide or moderate band on tongue. Anus placed about midway between normal position of first anal spine and ventral base. Scales minute, embedded, difficult to trace; cheek partly scaled, rest of head scaleless; side of belly scaleless, rest of body, to an irregular forwardly curved line running from origin of first dorsal to upper angle of gill opening, largely scaled, except irregular scaleless areas both above and below lateral line. Anterior curve in lateral line high, its

chord subequal to straight part; straight part of lateral line with 3–16 nearly normal scales in front and 24–38 scutes, the anterior scutes only moderately modified, becoming fairly modified posteriorly, the keel rather well developed, the spinous points moderate; total number of scales in straight part to end of scutes 36–46, a few normal scales behind scutes to end of hypural (not counted); accessory 1.l. reaching to over posterior margin of head or a little behind. Dorsal and anal changing markedly with growth. First dorsal with 7 short, pungent spines; partly disconnected, disappearing at the surface with growth. Second dorsal having first 7 rays filamentous, disconnected, graduated except the second often subequal to or longer than first, much prolonged, the anterior and longest rays one to four times as long as body, depending on the stage of growth and individual variability. The two separated anal spines short, hinged, disappearing with growth. Soft anal similar to second dorsal, except anterior 5, instead of 7, rays filamentous, disconnected and graduated. (Growth changes of fins described below.) Fold at base of dorsal and anal moderately developed; dorsal having 2–4 more rays than anal. Ventral moderately long, reaching nearly to normal position of first anal spine or moderately short of that point; notably long in the small specimens (see below). Pectoral long and falcate, reaching a little beyond posterior bend in lateral line. Caudal shorter than head.

Silvery or golden, suffused with a brownish tinge above. Color of young as follows: upper part of body with 4 broad cross bands not sharply marked, posterior 3 sometimes continued below, becoming fainter and obliquely placed on lower part of body; a dark transversely elongate blotch at upper posterior edge of opercle; a large black spot at base of prolonged dorsal rays, often also at base of similar anal rays; ventrals and filamentous dorsal and anal rays dark or black. With growth black colors largely disappearing.

Ontogeny.—This species undergoes extraordinary changes with growth. In the following description of such changes the given length refers to the standard length.

The spinous dorsal in 4 specimens 9–23 mm. consists of 7 rather short, pungent, subequal spines, except that the first is slightly shorter. They are only partly connected by a membrane, the distal ends being free. In 2 specimens 9–10 mm. the spines are moderately inclined backward in their normal position; with growth the angle of inclination increases until they come to lie closely apposed to the dorsal contour. The tips of most spines can be raised more or less with a needle in specimens up to about 155 mm. In specimens 185 mm. or larger the spines are not evident at the surface but some of them may be slightly raised under the skin. In the largest specimen, 444 mm., the spines have merged with the dorsal contour which is slightly irregular at the surface. Sometimes the spines have nearly disappeared in specimens as small as 95 mm., so that the tips of most of them can hardly or only slightly be felt with a needle.

The two separated anal spines are present and movable in 6 specimens 9–45 mm. These spines also disappear with growth but the size at disappearance varies greatly with the individual. In the next larger sizes to the above, in 3 specimens 51–76 mm. one of these spines is absent, and both are absent in a specimen 77 mm. The largest specimen with both spines present is 94 mm. Of 8 specimens 102–150 mm., 4 have one spine and in 4 both have disappeared. In 7 specimens 156–444 mm., both spines are absent, except one is present in one fish 187 mm.

The body depth and the pelvic length decrease strikingly with growth. The following gives the progressive change in these two measurements. The length of the specimens

measured is given first followed by the number of specimens in each category in parenthesis, then the range of the depth and finally that of the pelvic, both expressed as a percentage of the standard length. In very small specimens the ventral contour of the belly forms a deeply convex curve. The depth in such specimens was measured from the origin of the second dorsal to the apex of the ventral contour. In other specimens the depth was measured from the origin of the second dorsal to the origin of the anal (excluding the 2 separated spines), this distance being on a line somewhat inclined to the vertical. The measurements are as follows: 13 (1), depth 92 and pelvic 87; 20–28 (3), 98–106 and 74–77; 45–51 (2) 94–100 and 64–74; 75–96 (7), 86–99 and 50–55; 98–102 (4), 78–79 and 40–47 except 26 in one from Yucatan; 110–118 (4), 75–86 and 30–43; 129–166 (7), 67–78 and 21–29; 187–223 (3), 59–63 and 17–18; 444 mm. (1), 48 and 15.

It is difficult to determine accurately individual variability and growth changes in the length of the filamentous dorsal and anal rays, because these rays are more or less damaged in most specimens examined. Based on the study of such specimens as appear to have these rays entire or nearly so, the following tentative statements may be made: In specimens up to 157 mm. the longest dorsal rays vary from 2 to 4 times the standard length of the fish. In specimens 166–223 mm. their length is 1 to 2 times the standard length. (In the 444 mm. specimen the dorsal and anal lobes are broken.) The longest anal rays are usually more or less shorter than those of the dorsal.

Specimens examined from New Bedford and Woods Hole, Massachusetts; Newport, Rhode Island; Stonington and Noank, Connecticut; Great South Bay, Long Island; Hungers Wharf, Virginia; Cape Hatteras, Cape Lookout and Cape Fear, North Carolina; Charleston, South Carolina; Key West, Florida; Ambergris Cay, Yucatan, Mexico; Cuba; Jamaica; Colon, Panama; Santos (Market), Brazil. The largest specimen is 540 mm. (22″) from Key West.

The young of this species are recognizable on sight by the shape of the body, the steeply rising anterior profile, in combination with the very long, filamentous soft dorsal and anal rays. In large specimens the shape approaches that of *Selene vomer* and *Vomer setapinnis*, but they are separable by the presence of rather well developed spinous scutes, the less numerous dorsal rays and gill rakers, and the total disappearance of the spinous dorsal at the surface, in addition to other differences.

Synonymy.—Lutken (1880) who published an illuminating study of the remarkable changes that these fishes undergo during growth, uses Mitchill's name *crinitus* for the western Atlantic species. Nevertheless, Jordan and Evermann (1896), without comparing specimens, use Bloch's name *ciliaris* which was proposed for an East Indian fish, to designate this species, and this usage was generally followed by later American authors. However, considering that the East Indian species of fish are different from those in the western Atlantic, with very few rather doubtful exceptions, conclusive evidence is required to prove that any one species is common to both faunas. In such an instance, the burden of proof clearly rests on those who would synonymize names based on specimens of these two almost totally different faunas. To my knowledge no such comparison has been made adequately and convincingly. Therefore, I here use Mitchill's name *crinitus* for the western Atlantic species.

Poey described his *Hynnis cubensis* from a specimen 770 mm. in total length. The large mounted specimen from Florida which Nichols (1920) identified as *Alectis indicus* is 31 inches in standard length, or approximately 892 mm. in total length

(calculated on the basis of the published figure). The largest specimen examined by me is 538 mm. The depth of these three specimens measured at the anus, expressed as the number of times it enters the total length, to correspond with the figures given by

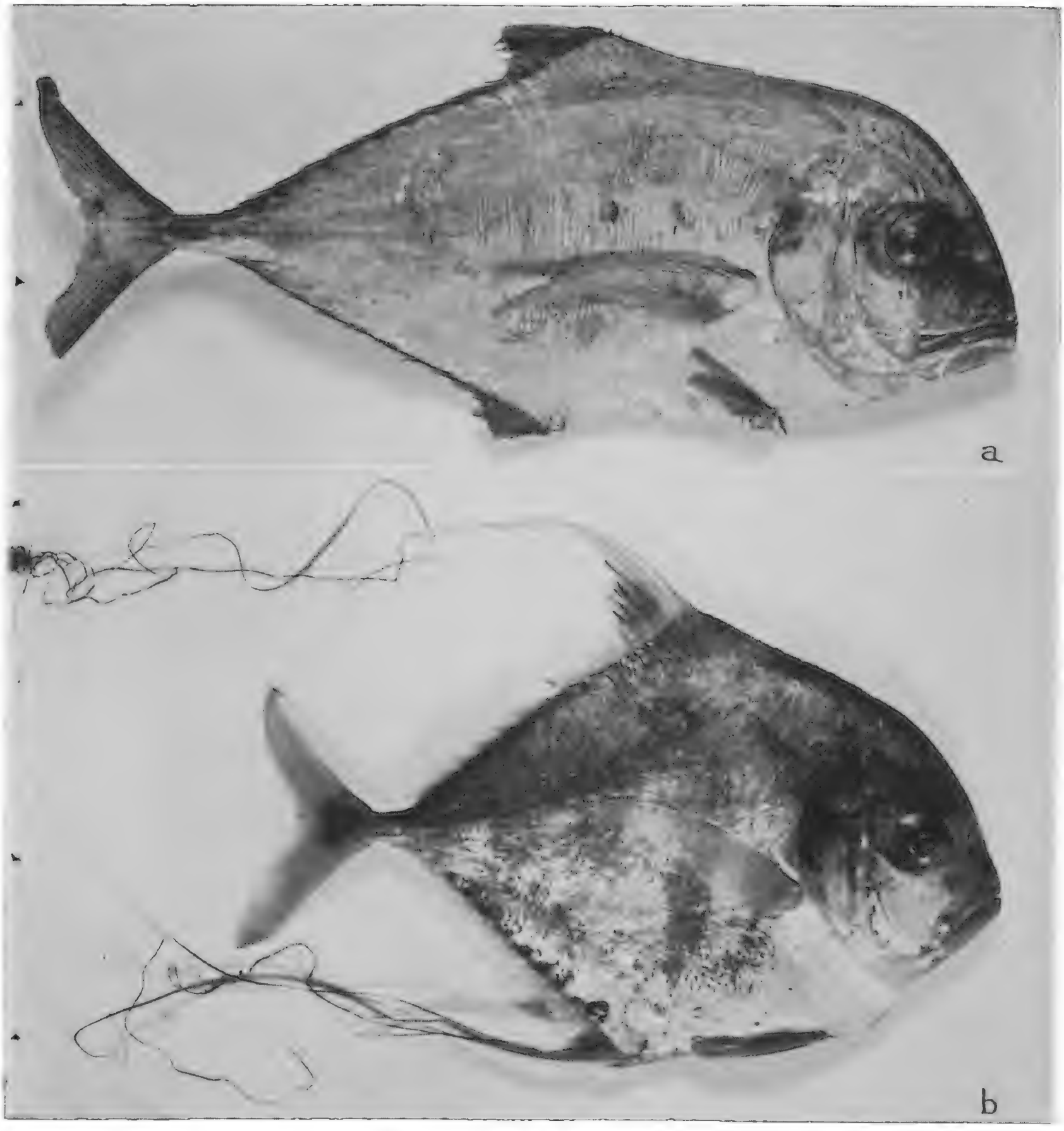

PLATE 6

Fig. a. *Alectis crinitus*, 534 mm Key West, Fla. USNM 34855. Dorsal and anal damaged in specimen figured. Judged by published descriptions and figures the anterior rays are not filamentous at this size.

Fig. b. *Alectis crinitus*, 190 mm Cape Lookout, N. C. USNM 74298. All specimens examined having anterior filamentous dorsal and anal rays more or less damaged and tangled or matted.

Poey, is: 538 mm., 2.7 times; 770 mm., 3.0 times; 892 mm., 4.1 times (calculated from the published figure). These three specimens then show a progressive decrease in the relative depth, as was shown above for the smaller specimens. The three specimens also agree in having 19 segmented rays in the dorsal and 16 in the anal. As they come from the same faunal region it is plausible to assume that they belong to the same species. The change in depth of the specimen described by Nichols seems more abrupt than could reasonably be expected, assuming that it belongs to the same species; but part of the difference may be ascribed to its being mounted and perhaps partly to the fact that measurements taken from photographs are not always reliable.

Nichols concludes that his specimen belongs to *indicus* on the basis of some proportional measurements. However, he made his comparison of the 31 inch specimen with one that is only 8 inches long. In view of the remarkable changes in form that these fish undergo with growth, a comparison of only two specimens differing so widely in size, cannot form the basis for a definite conclusion. Considering our present knowledge of these fishes, and geographic distribution in general, it is more likely that Nichols' specimen is a large example of *crinitus*.

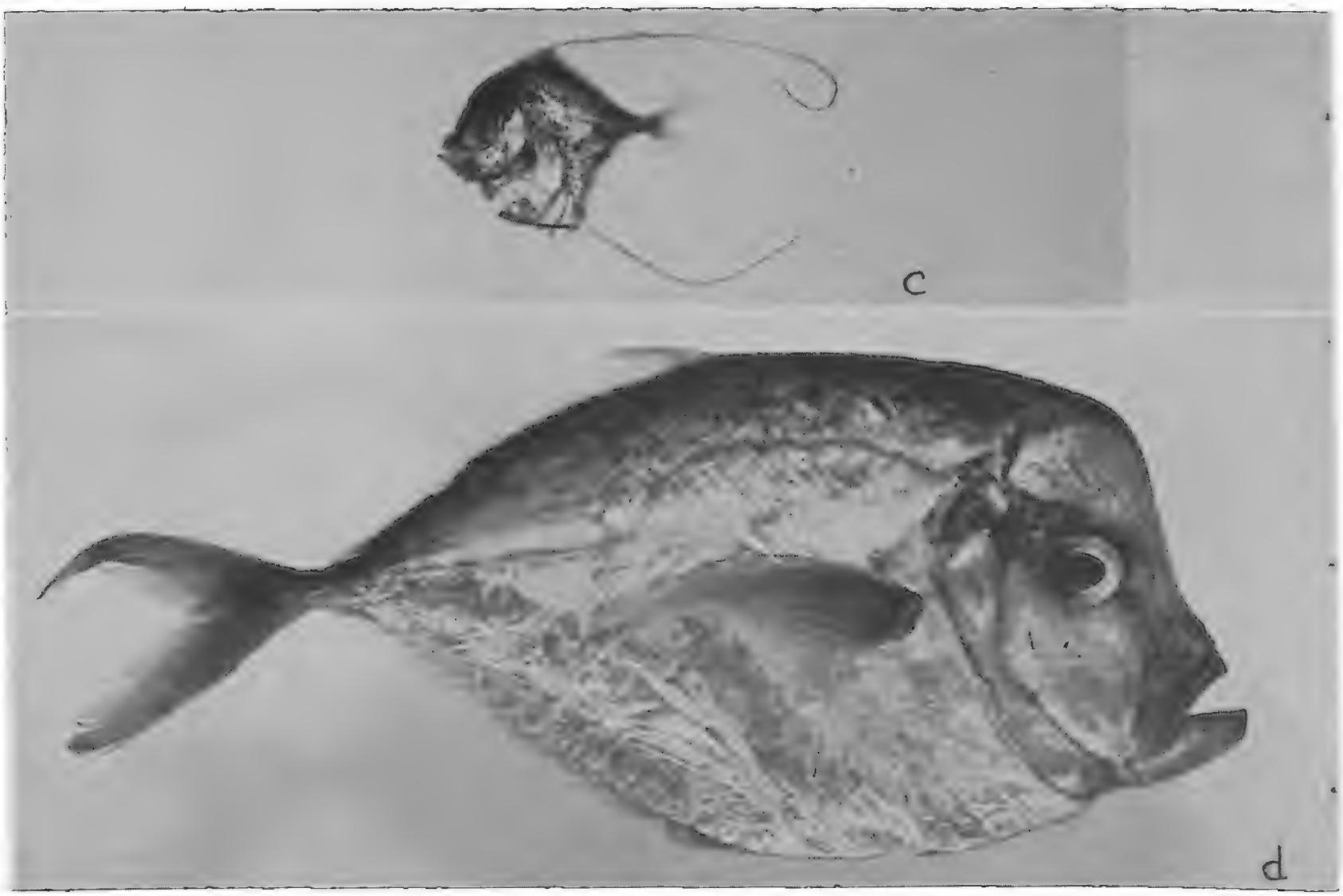

PLATE 6—(Continued)

Fig. c. *Alectis crinitus*, 10 mm in standard length, about 13 mm long. Cape Hatteras, N. C. USNM 148350. Only first dorsal and anal ray greatly prolonged at this size, and maximum prolongation not yet attained.

Fig. d. *Vomer setapinnis*, 225 mm Grand Isle, La. USNM 125793.

VOMER Cuvier

Vomer Cuvier, Regne Animal, p. 318, 1817 (genotype *Zeus setapinnis* Mitchill by monotypy)

This genus is nearest *Selene* and differs from it chiefly in having the anterior dorsal and anal lobes but little elevated, and in body shape. Other characters are discussed under the account of *Vomer setapinnis*.

Vomer setapinnis (Mitchill)

Moonfish, Plate 6, fig. d; Plate 7, fig. a

Zeus setapinnis Mitchill, Trans. Lit. Philos. Soc. New York 1: 384, pl. 1, fig. 9, 1815 (New York)

Vomer setipinnis Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 934, pl. 144, fig. 392, 1896 ("Tropical America on both coasts; from Maine to Brazil and Cape San Lucas to Peru").—Nichols, Bull. Amer. Mus. Nat. Hist. 31: 186, 1912 (Havana market; records also another species, *gaboensis*, from same place).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 226, fig. 132, 1928 (Chesapeake Bay)

Vomer setapinnis Meek and Hildebrand, Publ. Field Mus. Nat. Hist. (zool. ser.) 15(2): 366, pl. 29, fig. 1, 1925 (Atlantic coast of Panama; Pacific coast population described as distinct species, *declivifrons*).—Bigelow and Welsh, Bull. U. S. Bur. Fish. 40(1): 235, fig. 110, 1925 (Gulf of Maine).—Nichols and Breder, Zoologica 9:114, 1926 (Woods Hole, Mass.; Orient, N. Y.).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2): 707, fig. 317, 1936 ("Tropical seas. Described . . . from American (Middle States) examples.").—Gunter, Louisiana Conservation Review 5: 23, 1936 (common in shrimp trawls in Louisiana).—Gunter, Amer. Nat. 72: 79, 1938 (Louisiana).—Gunter, Ecol. Mon. 8: 334, fig. 11, 1938 (Louisiana).—Baughman, Trans. Texas Acad. Sci. 24:22, 1941 (Galveston to Port Aransas. Texas).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1): 58, 1945 (Texas: Louisiana; life history notes)

D VIII; I 20–23. A (II) 0; I 17–19. P 17–19. GR 25–29.

Dorsal rays modally 22 (10), often 21 (2) or 23 (2), sometimes 20 (1). Anal rays modally 18 (8), nearly as often 17 (6), sometimes 19 (1). Pectoral rays modally 18 (8), very often 19 (4), sometimes 17 (1). Gill rakers rather long, 5–8+25–29, sometimes a tubercle at end of upper limb; total gill rakers and tubercles on both limbs 31–37 (West Indian specimens seem to average fewer gill rakers; lower limit of range based on such specimens). Very deep, notably so in small specimens, 78–80 in 2 specimens 35–41 mm., 54–67 in 12 specimens 102–280 mm., 50 in 1 specimen 370 mm.; strongly compressed, outline of head and body trenchant; dorsal profile, from beginning of soft dorsal to an area over middle of eye, a nearly horizontal line; anterior profile from opposite eye upward, a nearly vertical line; the two lines described nearly perpendicular to each other, the angle between the lines rounded; lower profile to anal origin moderately rounded; profile at base of dorsal and anal fins a nearly straight inclined line to peduncle, that at anal base more steeply inclined; peduncle rather slender. Snout long, preorbital broad. Adipose eyelid fairly developed posteriorly, slightly developed anteriorly. Maxillary moderately broad, ending under anterior margin of eye or more forward;

supplemental maxillary moderate. Mouth small, inclined at about 45 degrees, superior, lower jaw projecting. Teeth very small, one row in lower jaw, a narrow band in upper jaw; a rather extensive patch on head of vomer, continued in a long narrow band on shaft; absent on palatines; a rather broad band on tongue, tapering anteriorly. Anus placed notably forward, near ventral base. Scales minute; antedorsal area and head scaleless; upper part, above a horizontal through straight part of lateral line to within a moderate distance from caudal peduncle, only partly and irregularly scaled, for the most part scaleless. Anterior curve in lateral line high, its chord only a little shorter than straight part; scutes nearly confined to caudal peduncle, not evident in the smaller specimens, only moderately developed in larger fish, not larger than adjacent normal scales, the keel only moderately indicated, no definite spinous point posteriorly; scales in straight part of lateral line, including the slightly developed scutes, 62–81; accessory lateral line ending under beginning of first dorsal. Spinous dorsal divisible into two parts, an anterior part consisting of 4 spines connected by membrane (easily torn), rather flexible, and a posterior part having 4 short, stout, pungent, disconnected, widely spaced spines; the anterior part changing markedly with growth; in the young prolonged, filamentous, the second spine a long filament, usually reaching more or less beyond beginning of soft dorsal, sometimes to its middle; the filaments lost early in life, only moderately developed at about 60 mm.; in medium sized specimens the four anterior spines short, slender, flexible, the first about half as long as second and longest, second to fourth graduated; the anterior 4 spines virtually disappearing with growth, sometimes at 240 mm., usually at a larger size; posterior 4 spines becoming relatively shorter with growth, in large specimens lying flat with their posterior surface closely attached to midback, their sharp points protruding backward. The two disconnected anal spines moderately indicated as fixed, projecting points in the small specimens (35 mm. smallest examined), disappearing with growth (at about 125 mm.); third anal spine, the one intimately connected with soft anal, broad and short and with a forward projecting spur in the small specimens, the spur lost early in life, becoming relatively longer and narrower but remaining pungent. Dorsal and anal lobe very moderate or slight, that of dorsal somewhat better developed; fold at their base very slightly developed for a short distance anteriorly; dorsal having 3–6 more rays than anal. Ventral very short, only moderately longer in small specimens, in a comparative way, its outer angle under lower pectoral angle or a little more forward. Pectoral long and falcate, reaching at some distance beyond posterior bend in 1.1. Caudal shorter than head (measured from tip of snout to posteriormost point of opercle).

Preserved specimens golden yellowish or silvery with a metallic bluish tinge above. The smaller specimens with a black spot on opercle, absent in young and disappearing with growth. Young with a rounded, transversely elongate black spot athwart beginning of straight part of lateral line and with transversely oblique, narrow, dusky band over eye. The black spot becomes faint between 60 and 80 mm. and disappears in larger specimens. The band over eye disappears sooner.

Gulf specimens examined from Corpus Christi Bay, Aransas Pass, Freeport and Galveston Bay, Texas; off Caminada Pass, off Grand Isle, Barataria Bay, off Grande Terre, and off Bastian Bay, Louisiana; Mississippi Sound; Pensacola, Florida. On the Atlantic coast specimens range from Magnolia, Massachusetts, to Tortugas,

Florida. Also, from Bermuda; Cuba; Haiti; Dominican Republic; Puerto Rico; Colon, Panama; Rio de Janeiro, Brazil. The largest specimen is 370 mm. (15″) from Newport, Rhode Island. The largest Gulf specimen is 170 mm. (7″) from Pensacola.

This species has a striking appearance because of its deep, strongly compressed body, and its unusual, rather irregular shape as compared with the usual body form

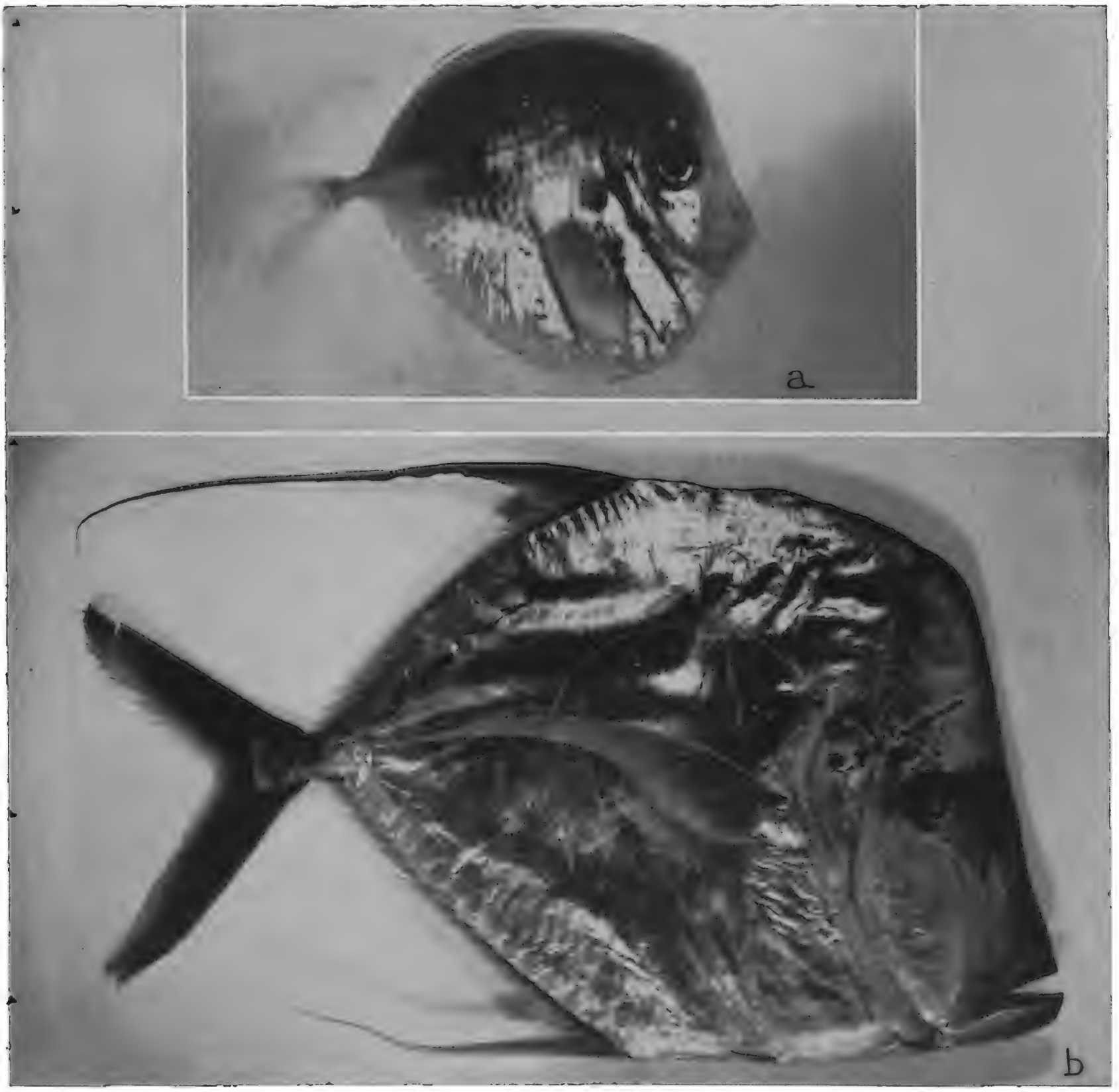

PLATE 7

Fig. a. *Vomer setapinnis*, 41 mm Grand Terre, La. USNM 144109. Second dorsal spine prolonged and anterior dorsal rays moderately longer than in adult in a comparative way, not well indicated in photograph.

Fig. b. *Selene vomer*, 235 mm Newport, R. I. USNM 26028.

of a fish. In appearance and relationship it is near to *Selene vomer* and differs from that species in not having the dorsal and anal lobe greatly prolonged, and in having the anterior profile nearly vertical, instead of well inclined. Young specimens of *V. setapinnis* do not have the first dorsal filaments as long as in *S. vomer*, the ventral is of moderate length, instead of being notably long as in that species, and they have a prominent dark spot on the body.

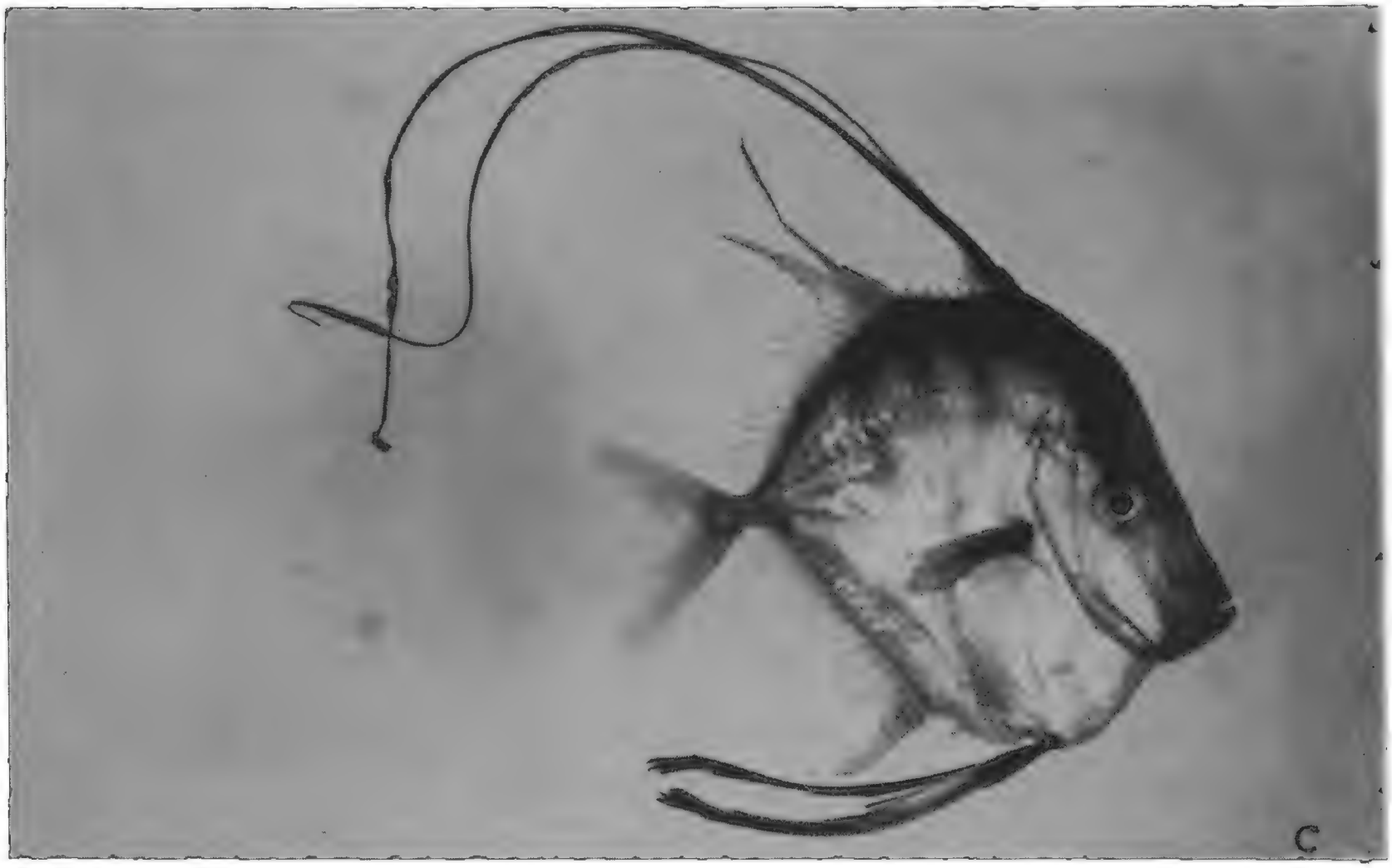

PLATE 7—(Continued)

Fig. c. *Selene vomer*, 34 mm in standard length, about 45 mm long. Beaufort, N. C. USNM 111775. The greatly elongated second and third dorsal spines and ventral fin becoming greatly reduced in large specimens, while the anterior dorsal and anal rays become much prolonged.

SELENE Lacépède

Selene Lacépède, Hist. Nat. Poissons 4: 560, 1802 (genotype *Selene argentea* Lacépède by later designation).—Jordan and Gilbert, Bull. U. S. Nat. Mus. 16: 439, 1882 (*Selene argentea* Lacépède = *Zeus vomer* Linnaeus designated as genotype)

Selene is nearest to *Vomer* as indicated under that genus.

Selene vomer (Linnaeus)

Lookdown, Plate 7, figs. b and c

Zeus vomer Linnaeus, Syst. Nat., p. 266, 1758 (America)

Selene vomer Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 936, pls. 144–145, figs. 393–393a, 1896 ("Tropical America, on both coasts, from Cape Cod

to Brazil, and from Lower California to Peru.").—Nichols, Amer. Mus. Nat. Hist. 31: 186, 1912. (Havana and Cienfuegos markets).—Meek and Hildebrand, Publ. Field Mus. Nat. Hist. Chicago (zool. ser.) 15(2): 372, pl. 31, 1925 (Atlantic coast of Panama; corresponding Pacific population treated as a distinct species, *brevoortii*).—Bigelow and Welsh, Bull. U. S. Bur. Fish. 40(1): 236, 1925 (Gulf of Maine).—Nichols and Breder, Zoologica 9: 115, fig. 155, 1927 (Woods Hole, Mass.; Orient and Sandy Hook Bay, N. Y.).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 225, fig. 131, 1928 (Chesapeake Bay).—Fowler, Bull. Amer. Mus. Nat. Hist. 70(2): 710, fig. 318, 1936 (New Jersey, North Carolina, West Indies).—Gunter, Louisiana Conservation Review 5: 23, 1936 (catch in shrimp trawls in Louisiana).—Gunter, Ecol. Mon. 8: 334. 1938 (Louisiana).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1): 58, 1945 (Aransas Bay and open Gulf, Texas).—Baughman, Texas Jour. Sci. 2: 246, 1950 (Texas, "fairly common")

Argyreiosus vomer Baughman, Trans. Texas Acad. Sci. 24: 23, 1941 (Rockport and Port Aransas, Texas, "not especially common")

D VIII; I 21–23. A (II) 0; I 18–20. P 20–21. GR 23–27.

Dorsal rays modally 22 (11), often 23 (4), sometimes 21 (1). Anal rays modally 19 (11), often 18 (4), sometimes 20 (1). Dorsal spines constant (15). Pectoral rays predominantly 20 (11), often 21 (4). Gill rakers rather long, 6–8+23–27, occasionally one tubercle at either end of gill arch; total number of gill rakers and tubercles on both limbs 31–34. Very notably deep, excessively so in small specimens, depth 81–90 in 4 specimens 32–75 mm., 68–80 in 4 specimens 90–130 mm., 68–74 in 5 specimens 145–195 mm., 69–72 in 2 specimens 220–240 mm., 63 in one specimen 317 mm.; strongly compressed, outline of head and body trenchant; dorsal profile, from beginning of soft dorsal to vertical over or behind eye, a nearly horizontal line; anterior profile, from opposite eye upward, a nearly straight, well inclined line, the two lines described forming an obtuse angle when continued, the actual angle rounded; lower profile to anal origin very moderately rounded; profile at base of dorsal and anal fin a nearly straight line, that at anal base a little more steeply inclined; caudal peduncle moderately slender (for a carangid). Snout and preorbital notably long. Adipose eyelid very moderately developed all around. Maxillary broad, ending on a vertical much in front of eye; supplemental maxillary well developed. Mouth small, rather well inclined, superior, lower jaw moderately projecting. Teeth minute, virtually in one row in lower jaw; in a narrow band in upper jaw; in a moderate band on head of vomer, continued in a long, narrow band on shaft; absent on palatines; in a rather broad band on tongue, on its posterior part, tapering anteriorly. Anus placed not far from ventral base. Scales minute; antedorsal area and head scaleless; body nearly all scaled, anterior boundary of scales a rather irregular line, running approximately from origin of first dorsal to upper angle of gill opening. Anterior curve in lateral line moderately high, its chord only a little shorter than straight part; scutes obsolescent, some of posterior scales in straight part of lateral line having the channel somewhat bulging outward, giving some suggestion of a rudimentary keel, but scales not definitely keeled and not spinous, not larger than adjacent ordinary scales; 62–74 scales in straight part of l.l.; accessory lateral line ending under beginning of first dorsal. Spinous dorsal divisible into two parts; anterior part having 4 spines connected by membrane; posterior part having 4 short, stout, pungent, disconnected, widely spaced spines.

increasing but slightly in length from before backward, almost subequal; anterior part changing markedly with growth; in young first and fourth spine of moderate length, either moderately pungent or somewhat flexible, second and third in form of excessively long filaments, the second longer than third, about twice as long as body or longer; with growth spines decreasing in relative length, second and third losing their filamentous structure; in grown specimens the first four spines reduced, short in comparison with most carangid species, pungent or rather flexible, the first spine very short, closely adherent to second, its presence usually detectable only on close scrutiny; second spine longest, thence graduated to fourth; posterior 4 spines similar in young and grown specimens, relatively somewhat smaller in large fish; all dorsal spines persisting with growth. The two disconnected anal spines very moderately developed in young, short, fixed (32 mm. smallest specimen examined); disappearing with growth (at about 150 mm.); third anal spine, the one intimately connected with soft part of fin, pungent; with a forward directed spur near its base, nearly disappearing with growth. Dorsal and anal lobe much prolonged, increasing in relative length with growth, in grown specimens first ray very long, often reaching to end of caudal or beyond, that of dorsal usually longer than that of anal; fold at base of fins poorly developed; dorsal having 3–4 more rays than anal. Ventral differing strikingly with size, greatly prolonged in young, nearly as long as body, very short in large specimens, its outer angle considerably in advance of lower pectoral angle. Pectoral notably long and falcate, reaching to within a moderate distance of caudal peduncle. Caudal shorter than head (measured as in *V. setapinnis* above).

Silvery or golden; back, above lateral line, with a metallic bluish tinge; first prolonged dorsal and anal ray often blackish; no distinctive color marks. Young having ventral and prolonged second and third dorsal spines, black, and with dusky somewhat oblique cross band; a band over eye, continued and tapering below eye; 4 or 5 interrupted bands on body usually very faint.

Gulf specimens examined from Harbor Island and Aransas Pass, Texas; Barataria Bay, Louisiana; Pensacola, Florida. On the Atlantic coast from Staten Island, New York, to Cape Sable, Florida. Also, from Tampico, Mexico; Cuba; Jamaica; Surinam; Gulf of Venezuela; Rio de Janeiro and Pernambuco, Brazil. The largest specimen is 317 mm. (12″) from Jamaica. The largest Gulf specimen is 195 mm. (8″) from Pensacola.

This species has a striking, unusual appearance, similar to that of *Vomer setapinnis* and the differences between the two species are discussed under the account of that species.

OLIGOPLITES Gill

Oligoplites Gill, Proc. Acad. Nat. Sci. Philadelphia 15: 166, 1863 (genotype *Oligoplites saurus* (Bloch and Schneider) by later designation).—Jordan and Evermann, Bull. U. S. Nat. Mus. 47(1): 898, 1896 (*O. occidentalis* Gill=*Oligoplites saurus* (Bloch and Schneider) designated as genotype)

This genus has an unusual combination of characters, namely, acicular embedded scales, lack of scutes, many finlet-like dorsal and anal rays, a non-protractile premaxillary and an unusually narrow maxillary. It is evidently not closely related to any one of the other carangid genera here treated. As far as external characters go,

it has more in common with the scombrids. The non-protractile maxillary is as in the scombrids and the narrow maxillary nearly as in those genera. The finlets are nearly as in the Scombridae, except that they are partly connected. The acicular, embedded scales are almost like those on the cheek of *Sarda* and *Euthynnus*.

Oligoplites saurus (Bloch and Schneider)

Leatherjacket

Scomber saurus Bloch and Schneider, Syst. Ichthy., p. 32, 1801 (Jamaica).

Oligoplites occidentalis Gill (not *Gasterosteus occidentalis* Linnaeus, according to Jordan and Gilbert, 1882), Proc. Acad. Nat. Sci. Philadelphia 15: 166, 1863 (Caribbean Sea)

Oligoplites saurus Jordan and Gilbert, Bull. U. S. Nat. Mus. 16: 973 and 447, 1882 ("Both coasts of Central America, and West Indies, north to New York and Lower California").—Jordan and Evermann, ibid., no. 47, pt. 1, p. 989, pl. 138, fig. 378, 1896 (same distribution as preceding).—Meek and Hildebrand, Publ. Field Mus. Nat. Hist. Chicago (zool. ser.) 15(2): 390, pl. 39, fig. 1, 1925 (Atlantic and Pacific coasts of Panama).—Nichols and Breder, Zoologica 9: 108, 1927 (Woods Hole, Mass.; New York).—Hildebrand and Schroeder, Bull. U. S. Bur. Fish. 43(1): 219, fig. 128, 1928 (Chesapeake Bay).—Baughman, Trans. Texas Acad. Sci. 24:23, 1941 (Texas).—Breder, Copeia 1942 (4): 267 (behavior).—Gunter, Publ. Inst. Mar. Sci. Univ. Texas 1(1): 60, 1945 (Texas).—Schultz, Jour. Washington Acad. Sci. 35:334, 1945 (Woods Hole, Mass. to Montevideo, including the West Indies; corresponding Pacific population treated as distinct subspecies)

D V (VI); I 19–21. A II: I 18–21. P 15–17. GR 13–15.

Dorsal rays modally 20 (15), often 19 (3), sometimes 21 (1). Anal rays modally 20 (10), very often 19 (6), sometimes 18 (1) or 21 (2). Dorsal spines normally 5 (18), sometimes 6 (1). Pectoral rays modally 16 (10), very often 17 (7), sometimes 15 (2). Gill rakers on upper limb 6–9, 1–4 at end short or tubercle-like; on lower limb 13–15 gill rakers with an occasional tubercle in front; total number of gill rakers and tubercles on both limbs 20–24. Elongate, spindle shaped, well compressed, moderately trenchant, except lower profile in front of anal; caudal peduncle moderate, compressed. Snout medium, rather pointed. Adipose eyelid very moderate. Premaxillary not protractile (the only carangid genus here treated having this character). Maxillary long, narrow, characteristically curved distally, ending under posterior margin of eye or a little short. Mouth large, oblique, subterminal, lower jaw slightly projecting. Teeth moderately small; in two rows in jaws, the rows characteristically well separated; a rather wide band on vomer, tapering backward, of medium length; palatine band of teeth medium; tongue nearly all covered with granular teeth, except a narrow marginal strip. Anus placed near first anal spine. Scales acicular, long and very narrow (the only Gulf species having this type of scales); well embedded, but their outlines visible at surface; body and antedorsal area scaled to opposite preopercular margin; head and fins naked. Lateral line making a fairly marked upward angle at a moderate distance from its beginning, thence descending moderately and merging imperceptibly with posterior straight part; no scutes; accessory l.l. short, extending but slightly backward. First dorsal normally with 5 spines detached from one another, short, pungent, increasing moderately in length from first to last; in

small specimens spines relatively better developed, longer and stouter, partly attached to one another, the fifth (or sixth) also partly attached to soft dorsal. Anal similar to dorsal in structure and development, the first two spines detached and moderately developed in large specimens. Posterior dorsal and anal rays, having a characteristic structure, the base comparatively narrow, fanning out distally with a profusion of branches into a wider expanse, each ray partly detached from adjacent ones, presenting gross impression of a series of finlets partly attached; transition from anterior and fewer normal rays to posterior and more numerous modified rays gradual; anterior dorsal and anal rays moderately elevated; fold at their base obsolescent, very slightly indicated for a short distance anteriorly; majority of specimens having same number of rays in dorsal and anal, often dorsal having 1–2 rays more, sometimes anal having 1 more than dorsal. Ventral moderate reaching to about half the distance from its base to soft anal origin; its outer angle under lower pectoral angle. Pectoral short, reaching a vertical through end of ventral or a little short. Caudal subequal to head length.

In preserved specimens body and head above a lengthwise line through upper angle of opercle dusky or with metallic bluish sheen; the lower part silvery or golden; or silvery nearly all over; the fins yellowish; no distinctive color marks.

Gulf specimens examined from Corpus Christi Pass, Corpus Christi Bay, Mustang Island, Aransas Pass, Harbor Island, St. Joseph Island, Galveston and Dickinson Lake, Texas; Isle Derniere, Barataria Bay and Bay La Mer, Louisiana; off Gulfport, Mississippi; Sand Island, Alabama; Pensacola, St. Joseph Bay, Apalachicola Bay, Ochlockonee Bay, and Tampa Bay, Florida. Also, Woods Hole, Massachusetts; Newport and Wickford, Rhode Island; Spring Lake, New Jersey; Key West and Tortugas, Florida; Cuba; Jamaica; Puerto Rico; Colon reef, Panama; Puerto Colombia. The largest specimen is 282 mm. (11″), from Cuba. The largest Gulf specimen is 241 mm. (9″) from Pensacola.

This species is easily separable from all Gulf coast fishes by the long, narrow, needle-shaped or spicule-like scales which are embedded in the skin, but the outlines of which are visible at the surface. Other unusual features are the non-protractile upper jaw, and the structure of most dorsal and anal rays which are fan-shaped and in the form of finlets attached to one another at their bases. Some other species of *Oligoplites* occur in the West Indies and Central and South America and also on the west coast, but this is the only species found in the Gulf.

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Historical Changes in the Mississippi River and the Adjacent Marine Environment*

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1. Introduction*

The Gulf Coastal Plain joins the Atlantic Coastal Plain on the east and extends into Mexico. It averages about 200 miles in width. Where the central Gulf Coastal Plain is crossed by the Mississippi River there is an inland extension of the plain to the Missouri-Illinois region, 600 miles from the Gulf of Mexico, called the Mississippi Embayment. Most streams of this region are tributary to the Mississippi, although a few run to the Gulf independently. A large central part of the Embayment and the Central Gulf Coastal Plain is covered by the Mississippi Alluvial Valley.

The Mississippi River is a "newcomer", having first entered the region when the streams of the central United States were diverted southward by the growth of the North American Ice Cap. Oscillations in sea level accompanying the several advances and retreats of the Pleistocene glaciers caused the river to incise and alluviate its valley.

During the time of the last ice sheet, the Wisconsin, 25,000 to 30,000 years ago, the sea level was at least 400 feet lower than it is today. The entrenched valley is filled with alluvium of Recent age, which was deposited during and subsequent to melting of the glaciers. As the sea level rose stream slope decreased and the river gradually lost carrying capacity. During incisement stages the slope was steep and small stones were carried to the seashore. As the gradient decreased large particles were carried shorter distances and today sand grains are not ordinarily carried farther down than the White River region of Arkansas. The filling in or slow aggradation of the entrenched valley system has been termed "alluvial drowning" by Russell and Howe (1935).

The alluvial plain includes both the floodplain and the alluvial plains which are not covered by flood waters. Streams of the valley have large stage variations and in their natural state periodically overflow their banks. Sediments deposited on the banks by high water form natural levees sloping away from the river at a gradient of about seven feet to the first mile; thus large flood basins, which are cut off from the channel at low water stages, exist between the river and escarpments of the valley. The river and its tributary streams drop sediments in these basins and aggrade the valley. The Mississippi floodplain covers 35,000 square miles, including 15,000 square miles of deltaic plain.

The Mississippi watershed is exceeded only by those of the Amazon and the Congo and covers 1,244,000 square miles or approximately one-third of the United States and 13,000 square miles of Canada. The average annual rainfall over this area is about 30 inches, of which about one-fourth travels to the sea by way of the river. The annual water discharge at the mouth of the Mississippi has been estimated at 785,-190,000,000 cubic yards and the sediment carried into the sea is between 1,000,000 and 2,000,000 tons a day.

The above information is largely taken from Russell (1936) and Fisk (1944, 1947).

Russell and Howe (1935) have pointed out that the Mississippi may be termed the "Father" of Gulf coast geology and geomorphology. It has a commensurate relation to the estuarine life of the region. The center of production of the white shrimp *(Penaeus setiferus)*, of the South Atlantic and Gulf Coasts of the United States, is in Louisiana. It is significant that the two main centers for blue crab and oyster fisheries

*This paper is based upon a report to the Texas A. & M. Research Foundation and the writer is indebted to officials of that organization in many ways. Thanks are due Mr. M. D. Burkenroad and Dr. S. H. Hopkins for helpful suggestions and criticism.

are widely separated at two large estuarine areas, the Louisiana Coast and Chesapeake Bay. Other items could be mentioned, but the importance of the Mississippi River to the life of the adjacent sea is self-evident and there is no need to belabor the point.

It is obvious that changes in this vast river system, even those which might be negligible or transient from the geological viewpoint, would have far-reaching effects upon the life of the valley and the marine area at its mouth. Price (1947) has pointed out the difference in this respect between the viewpoint of the biologist and the gelogist. He says (p. 1657), concerning sedimentation, "What to the geologist may be an incidental shallow scour and fill—may involve considerable restriction and local extinction of biological communities, especially of the bottom dwellers."

The purpose of this paper is to consider some changes that have taken place near the mouth of the Mississippi River in historic times and their probable and known effects on the marine life of the region. Much information on the gelogical and artificial changes in the river is to be found in various geological papers, reports of the U. S. Engineer Office and the Mississippi Valley Commission and in other places. There is also a considerable amount of unpublished data. It is not our purpose to itemize or review this information in any greater detail than is necessary to show broad, general trends as a background for consideration of factors which have effected biological changes in the marine area near the river's mouth.

2. Historical Changes in the Mississippi River System and their Effects on the Delta.

a. Levees

Usually the Mississippi is low in the late summer and fall. A small rise in early winter is stopped by freezing in the northern reaches and the large annual rise follows the general thaw. The high water crest usually comes from March to May, but may be as early as January.

Floods have been noted since 1543, when De Soto's party saw a rise in March, extending for several leagues on each side of the channel. La Salle's party reported the same situation in 1684 (Russell, *op. cit.*). The initial settlement of New Orleans was held up by floods in 1717. In its natural condition the river annually overflowed its banks and spread out over the flood basins for many miles on either side. This situation made levees necessary from the time of first settlements of white men in Louisiana.[1] A flood has been defined as a water stage high enough to overflow the natural levees or banks of the river. Elliot (1932) gave a list of 58 recorded major floods between 1717 and 1929. This is an average of one every 3.6 years.

The first levee on the Mississippi River was constructed around the city of New Orleans when it was founded in 1717. It was not completed until 1727. This was in the area now known as the Old Square or the French Quarter. The levee was 5,400 feet long and built in the form of a quadrangle because there were no adjoining levees up and down the river and the protected area had to be completely enclosed to prevent the backwaters from coming in behind. The levees was only about 3 feet high, which was sufficient in that day. It was called in French *banquette*. The enclosed area was often muddy and impassable to pedestrians who walked instead upon the higher ground of the banquette. For that reason the people of New Orleans to this day refer to their concrete sidewalks as "banquettes."

[1]If the early white settlers had decided to live with the river rather than fight it, the development of life in the valley would have taken quite a different course, of which some of the advantages have been mentioned by Viosca (1927). Other advantages and disadvantages could be mentioned, but the "point of no return" on this issue was passed long ago and further discussion is fruitless.

Throughout the years levees were extended up and down the river. Early grants from the King of France carried the stipulation that owners would levee the river. By 1728 levees extended for 30 miles above New Orleans and by 1735 extended 12 miles below. In 1736 an edict was issued which gave all river front owners until 1744 to throw up levees, with confiscation of the land being the penalty for failure (Mem. La., 1892). The burden originally fell unfairly on these owners, while owners of land not bordering the river bore no expense. By 1812 the levees extended upriver to Baton Rouge and Pointe Coupee. No united plan of levee construction was introduced until the severe flood of 1828 caused the legislature of the State of Louisiana to take action and legally require some organization. In 1850 the federal government gave 8,500,000 acres of lands to states subject to floods, with the proviso that the land be sold and the proceeds used for levee construction. Up until 1873 most levees were constructed by riparian owners. At that time the State began to bear the expense. The Mississippi Valley Commission was established in 1879. After 1882 this body carried on considerable levee construction, ostensibly as an aid to navigation. In the seventies Levee Districts were organized. The levee system had deteriorated extensively during the Civil War and vast repairs were necessary. Later, flood control was recognized as a national problem and finally the federal government took complete charge of the Mississippi levees in 1928, following the disastrous flood of 1927.

Levees grew ever higher as the river was cut from its flood basins and so did floods. Today levees at some points are thirty-five feet high.[2] In addition many tributary streams were leveed and they in turn were cut off from their flood basins. Maps of the present system show a bewildering tracery of levees, quite difficult to describe in detail, which however is unnecessary for our purposes. It is sufficient to say that the total levee system was around 991 miles long in 1880 and 2,130 miles long in 1935.

Up to 1885 the effects of levees were not so great as they have become since. According to Elliot (1932, p. 83) the flood of 1882 may be taken as typical of a major flood prior to extensive levee construction. "Comparison of succeeding flood crests with this flood gives a definite indication of the increase in flood heights." He gave figures taken at the Carrollton (New Orleans) gauge showing that the crest was at 14.95 feet in 1882, 16 feet in 1890 and 21 feet in 1912. The Red River Landing gauge registered 48.50 feet in 1882, 53.20 feet in 1912 and 57.45 feet in 1927. The greatest flood of all was in 1927 when numerous crevasses modified flood heights on the lower river, making them useless for comparison. At the Cairo, Illinois, gauge the 1927 high water crest was at 56.4 feet. The highest previous crest was at 54.69 feet in 1913. At the time of the 1912 flood the gauge stood at 54.0 feet.

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[2]There is a widespread misconception among the laity, even in ordinarily responsible quarters, that levees have caused the river bed to rise. In the extreme the river in its lower reaches is concived to be something like a large flume flowing higher than much of the adjacent lowlands and held in course only by retaining walls of dirt, the levees. The idea is so palpably erroneous, as the briefest glimpse of the low stage river will show, that it would scarcely be worth refuting were it not for its wide prevalence. Another twist to the idea is that this supposed situation is the result of long years of flood control effort by the U. S. Army Corps of Engineers. The truth is that the Engineers were only empowered to take over the whole levee system, then somewhat dilapidated in 1928, while the system had its beginning in 1717, as noted above.

Major changes in the level of the river bed have not been demonstrated except for purely local variations, but the tendency has probably been for the river bed to degrade rather than build up as a result of artificial works. The river has been somewhat straightened and shortened and the floods have been retained within narrower limits, creating faster flow and greater cutting power.

In summary, levee construction started in 1717, 235 years ago, at New Orleans and was a gradual process up until about 1880. From that time the rate was accelerated, until the nineteen-thirties when the whole system was greatly extended and more or less stabilized, following the disastrous flood of 1927. Flood heights became higher as the levee system increased.

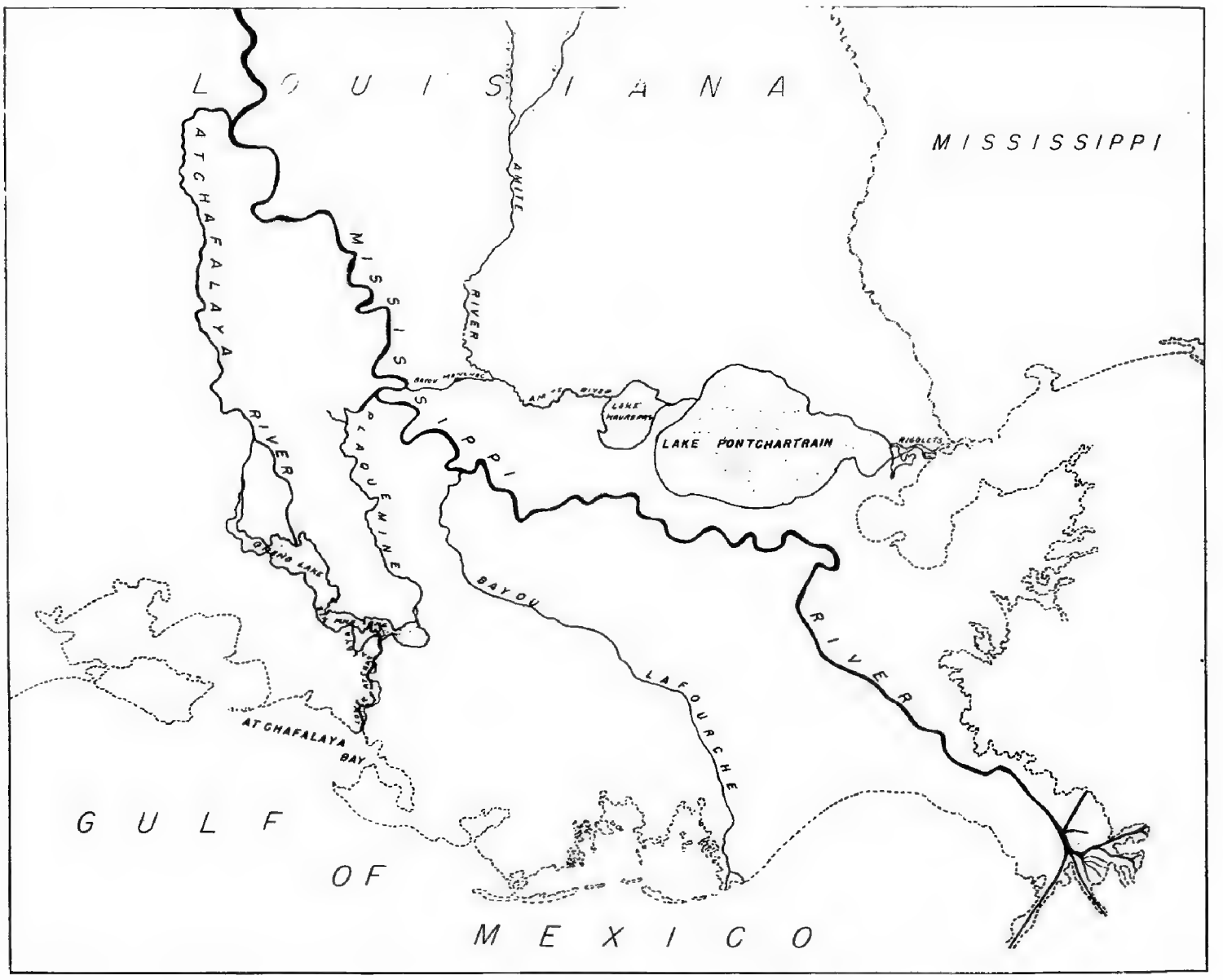

PLATE 1

Semi-diagrammatic map of the Mississippi River distributaries.

b. Changes in the Distributaries

The Deltaic Plain of the Mississippi covers some 15,000 square miles and extends northward to the beginning of the Atchafalaya River, 140 miles from the sea. The course of the main river is 216 miles from this point to the sea. The Mississippi has several natural flood outlets in this delta region. The only large eastern one is Bayou Manchac, which heads about 15 miles south of Baton Rouge and flows into Lake Maurepas. It was dammed at its source in 1828. On the west bank Bayou Plaquemine heads at the town of the same name and flows 80 miles to the Gulf. It was blocked off from the river by the construction of the west bank levee in 1868. A navigation lock was installed there in 1909. Bayou Lafourche heads at Donaldsonville and flows along an old river channel 90 miles to the Gulf. It was

dammed off from the river in 1904. Thus three of the four main distributaries of the Mississippi, one on the east bank and two on the west bank, were severed from the river between 1828 and 1904. Since their severance they have not distributed flood waters except at irregular periods when breaks in the levees, the notorious crevasses, allowed water to flow into them.

Bayou Lafourche, Bayou Plaquemine and the minor flood distributaries which doubtless existed previous to the levees, spread large quantities of fresh water from the Mississippi every spring over a wide area of the Louisiana Coast. This water drained into Terrebonne, Barataria and adjoining smaller bays over a hundred mile segment of the coast west of the river. Bayou Manchac and minor distributaries east of the river drained flood waters into Mississippi Sound and adjacent waters east of the river. Today, the annual spring flood waters which formerly flowed into this wide estuarine and bay area are all channeled in the main stream of the river and flow out at its mouth into the open Gulf of Mexico. The Bonnet Carré Spillway has been opened three times since its completion in 1932 and constitutes an exception to the above statement. However, it is a special case and will be discussed later.

Farther to the north on the western bank, just below the mouth of the Red River, is the Atchafalya. The history of this flood distributary has been quite different from that of the others. The Atchafalaya River follows an old bed of the Mississippi and within historic times it was merely another flood distributary comparable to Bayou Lafourche and Bayou Plaquemine farther down. In former years it was commonly referred to as Atchafalaya Bayou. Its size and carrying capacity in the early historical times are unknown, but they were quite small. Eighty to ninety years ago there was a little foot-bridge across it in Avoyelles Parish, near the present town of Simmesport. The writer once talked to an old Creole gentleman of that region who drove cattle across the Atchafalaya at a "ford" during low water stages approximately eighty-five years ago. When the lower flood distributaries were blocked off by dams and levees the Atchafalaya began to increase in size. This process possibly began 120 years ago at the time when Bayou Manchac was blocked off below Baton Rouge. The removal of a raft in the river between 1840 and 1860 and extension of the levees brought about rejuvenation of the stream. It was greatly accelerated by the increase in levees after 1880. According to Elliott (1932), this stream carried 77,061 second feet of water in 1858 and 592,100 in 1927, at high water stages. Today at minimum stages the Atchafalaya River is exceeded in flow only by the Ohio and the Mississippi rivers. At high water stages it is exceeded by the Arkansas, Missouri, Ohio and Mississippi. During flood stages it carries over a fifth of the Mississippi's water to the Gulf. This river has been called by engineers "the thieving Atchafalaya" because it has been growing at the expense of the Mississippi. The report of the Mississippi River Commission for 1879 contained an estimate of costs for checking the enlargement of the Atchafalaya. A reporter for The New Orleans Times-Democrat, March 29, 1882, who was viewing the flood of that year wrote as follows: "The current running down the Atchafalaya was very swift, the Mississippi showing a predilection in that direction, which needs only to be seen to enforce the opinion of that river's desperate endeavors to find a short way to the Gulf." During the 1927 flood it increased approximately 22 per cent in size. Government engineers are faced with the problem of preventing the Atcha-

falaya from becoming the main channel of the Mississippi system and large scale operations for its control are being considered. In short, the Atchafalaya has grown in a hundred years' time from a small stream or bayou to one of the major rivers of America. Obviously it has effected great changes in the marine area at its mouth.

The Atchafalaya Basin is enclosed on the east, from the head of Bayou Lafourche southward, by the Lafourche Ridge. On the west it is enclosed by the Bayou Teche Ridge. The Natural levee of the Atchalalaya (the Atchafalaya Ridge), bisects the upper Atchafalaya Basin, but according to Fisk (1944, p. 32) becomes of decreasing significance southward. Nevertheless, the waters from this river are shunted to the west of Terrebonne Bay into Atchafalaya Bay, which is separated from the former by a strip of marshland and lakes about fifty miles wide. During the 1927 flood some Atchafalaya water reached as far west as Vermilion Bay (Frankenfield, 1927). Later engineering structures are shunting more water westward. Therefore, most of the central coast of Louisiana is affected and biological conditions there have been changed in recent years by the influx of the increasing amounts of fresh water from the Atchafalaya; while from the central region eastward to the Mississippi River there has been less water drainage.

Looked at in a somewhat schematic way, the Mississippi formerly discharged its water over a somewhat arc-like or triangular area, with the main flow at the mouth or center into the open Gulf and a diminishing amount of fresh water flowing towards the ends of the arc into the bays and Mississippi Sound. At present this central flow has increased, as has the flow at the westernmost part of the arc, at the expense of the other parts of the area. Thus the open Gulf near the mouth of the river and Atchafalaya Bay get more fresh water now than in the past, while Terrebonne, Barataria and adjacent bays, and Mississippi Sound get less. These latter areas formerly received flood waters seasonally every year. A seasonal cycle in salinity resulted. Although the mouth of the river carries more water than formerly and some of it of necessity gets into the bays through the passes and seaward channels, this water is mixed with sea water and is no longer fresh. This situation also prevailed to some extent previously and it is very improbable that an increased influx of partly saline water from seaward would lower bay salinities as much as the former larger amounts of pure fresh water from land. Therefore, there is doubtless less of an annual cycle in salinity and the bay salinities are higher.

c. Crevasses and Spillways

The condition just described is upset or disrupted when the levees break during the higher floods or the spillways are opened. The effects on the bays are then similar to those of the unimpeded flow of the annual spring floods except that they are more concentrated on local areas, come faster and in general are more extreme. Needless to say these occurrences are not annual but are quite irregular. The difficulty of man's struggle to control the Mississippi with levees is shown by the fact that approximately 450 crevasses have been recorded between 1717 and 1930. Many of these, however, occurred far upriver and did not cause an influx of silt and fresh water into the coastal bays.

Most information on the crevasses which affected the bays is to be found in reports of the Louisiana Department of Wild Life and Fisheries and its predecessors. This information has been reviewed (Gunter, 1949). The Nita, Poydras and Caernarvon

crevasses on the east bank of the river in the years 1890, 1922 and 1927 carried large amounts of water into the bays. The first, aided by some 19 smaller crevasses, was reported to have killed every oyster in St. Bernard Parish. The Ames, Hymelia, Myrtle Grove and Junior crevasses in 1891, 1903 and 1912, 1922 and 1927, respectively, similarly affected the bays west of the river.

Since 1927 there have been no crevasses on the lower river. However, the opening of spillways has much the same effect as a crevasse. There are two spillways on the lower Mississippi. They were constructed as an adjunct to the levee system. However, the so-called Bohemia Spillway or Pointe à la Hache Relief Outlet consists merely of a series of gaps cut in the east bank levee above the town of Buras, at the site of old crevasses in 1850 and 1874. It was made by the New Orleans Levee Board and was completed in 1925. This spillway is so far down the river that it can reduce flood heights little. It was opened during the 1927 flood, but did not prevent crevasses. It flows at least a little almost every year. During the 1940–50 decade the average flow has been around 1,712,000 acre feet a year, with the greatest (7,447,000 acre feet) flow in 1945. It has silted rapidly. In 1927 this spillway carried approximately 300,000 second feet of water, while in 1949 it carried around 11,000 second feet at the same gauge height. The Department of Conservation reported that the Caenarvon crevasse and Bohemia spillway destroyed one-third of Louisiana's entire oyster crop in 1927. It was also reported that this spillway caused damage to oysters in 1943. The latter report seems to be erroneous (Gunter, 1949). At that time Bohemia carried a maximum of around 90,000 second feet of water.

The Bonnet Carré spillway was constructed by the U. S. Army Engineers 24 miles above New Orleans on the site of an old crevasse. It empties water into Lake Pontchartrain and thence into Mississippi Sound. It was in operating condition in 1932 and was first used in 1937 when it was opened from February 4 to March 16, with a maximum discharge of 210,000 second feet. On the other hand the 1945 opening of this spillway from March 23 to May 20, with a maximum discharge of 318,000 second feet, was reported to have caused extensive damage to oysters in Louisiana and Mississippi (Anderson and Power, 1949). The spillway was opened again on February 10, 1950. No damage was caused. The spillway question was discussed in considerable detail by Gunter (1950).

d. Rising Sea Level

Before taking up the changes in the bays wrought by the levee system it is necessary to consider the matter of rising sea level, the effects of which parallel and supplement in some ways the effects of levees on the bays.

It is a well-known fact that the area around the Mississippi Delta is sinking. Lyell noted the fact in 1849 and Brown (1902) commented on it. Trowbridge (1930) has shown that old prosperous plantations have been reduced to marsh. Russell (1936) gave a great deal of evidence of sinking and presented an argument for his belief that the Gulf Coast Geosyncline, now known to contain sediments 30,000 feet thick (Fisk, 1947), is caused by loading. Russell also presented reasons for believing that the whole Gulf Coast is sinking. This has been verified by Gutenberg (1941) by other means. Russell (1948) summarized information on Louisiana coastal geology.

Aside from deep-seated causes in the earth's crust, the rise in sea level along the Louisiana coast may have three causes. One of these is compaction. Local sinking

through softer underlying deposits also takes place. The marsh and swampy deposits of the delta are soft and have a high percentage of water at the surface. The numerous "trembling prairies" of the Louisiana Coast are evidence of this fact. Drainage of farm lands on the lower river and of areas within the city of New Orleans has been followed by local subsidence. Barton (1933) has estimated the amount of compaction of sediments of the coastal plain as varying from one-tenth to one-sixth, approximately, depending on depth of the column. Russell calculated that about one-eighth of sinking of the delta was due to this cause. Locally, compaction may go on at a greater rate. Fisk (*op. cit.*, p. 34) and others have pointed out that natural levees formed over soft marsh deposits sink of their own weight and may continue to do so after the stream bed is abandoned. Russell (1936) has shown that Indian kitchen middens sink and that surveyed markers on the lower delta have sunk at the rate of about eight feet a century. The writer has seen chenieres near lower Vermilion Bay which have sunk to the level of the marsh, and others seem to be in the process of sinking. It is probable that some have sunk entirely beneath the marsh surface.

A second cause of the sinking coast might be depression of the earth's crust by the sediment load of the river (see Russell, *op. cit.*). A third cause, the rise of the sea level due to continued melting of the polar ice caps, is termed eustatic.

Various estimates of sinking in the lower delta region, summarized by Russell, give rates varying from 0.05 to 0.163 foot per year. Gutenberg (1941) has presented data indicating that the coast at Galveston has sunk at the rate of 48 cm. a century (0.19 inch a year) between 1909 and 1939. He estimated that 10 cm. of this change was eustatic.

3. Changes Within the Valley

The whole Mississippi floodplain has probably never all been flooded at one time. In some places it is about 80 miles wide from east to west and it averages about 40 miles (Fisk, 1947). Father Charlevoix and the early French explorers spoke of the river as spreading to 50 miles in width during the flood stage in the spring. How much water and how much sediment the river carried in the days before its watershed was subjected to the influence of the white man is unknown. Probably the annual water discharge was much the same as it is today. However, the undisturbed plant cover of the watershed retarded the run-off, thus giving a more continuous flow throughout the year and causing the flood stages to be less in height. Since the hinterland was not denuded of vegetation, the amount of sediment entering the river system was not as great as it is today. Furthermore, the river spread unrestricted over the flood basins and there deposited a large part of its sediment load.

Therefore, before the Mississippi River System watershed was settled by the white man three factors were operating differently from what they do today, tending to give the river less silt load and to keep the flood stages low. Today much of the hinterland has been denuded of plant cover. The amount of silt reaching tributary streams and the main river is much greater and the run-off is much faster. This causes a sharper and higher peak of flood stages. It is to be hoped that with the introduction of soil conservation practices the stress of this factor has passed its peak. Lastly, the river is now largely walled off from its flood basins, it cannot deposit its silt load and for the same reason does not aggrade its valley as rapidly as in the past. The levee system, as well as denudation of the watershed has caused higher and higher

floods. The exact part each factor plays is, of course, indeterminate but the higher and higher flood stages are attested to by the higher and higher levees, as well as by the higher measurements on flood gauges. These are self-evident facts. In short, the influence of man has been to cause the Mississippi River to carry greater and greater amounts of silt and flood water all the way down to its mouth and into the Gulf of Mexico. Engineers have recognized that the rate of flow or "hydraulics" of the leveed river is much better than it used to be. The current rate at flood periods is around 8 feet per second in the main river. In the overflow basins the water flows south at only about 0.8 feet per second. The faster run-off and higher flood stages increased the current rate, at least for short periods, and thus increased the silt load. Apparently the the same changes took place in the unleveed Texas rivers (Price and Gunter, 1943).

As a side issue to the main consideration of this paper we might stop for a moment to consider the influence of the changes of the river upon the life of the river and its flood basins. Here we are without exact information but certainly the changes have been extensive. It is quite generally true that much of the fish life of the rivers spawns in the spring in backwaters and flood basins where the larvae have food and quiet waters. Today a large part of this former nursery and feeding-ground is cut off. As a result the muddy main stream is comparatively barren to what it was in earlier days. There as doubtless been a comparable decrease in waterfowl and all other forms of life which subsisted in and around the former vast overflow areas.

4. Physical Changes in the Bays

In the previous topics the factors or forces of the river and the coast which would bring about changes in the bays, physical and otherwise, have been outlined. We will now consider the changes which have taken place in the bays.

The river, through its distributaries, formerly cast large amounts of fresh water and sediments into the bays adjacent to its lower reaches and aggraded them. With this source of sediment cut off, it is logical to assume that under the influence of a sinking coast, the islands and surrounding land would begin to waste away. Apparently, that is what happened.

Russell (1936, p. 49) said, "Since the building of the artificial levees beyond Poydras, there has been practically no sediment carried into St. Bernard Parish by streams. With the cessation of land extension and upbuilding, the forces of destruction have had full sway. These include the action of waves and currents, particularly along the eastern side of the mainland, and subsidence, evident anywhere." He gave a map showing losses of area from islands and the mainland in the Creole Gap-Grand Pass region of Mississippi Sound between 1917 and 1932. He added that this was typical of the whole coast of St. Bernard Parish. The parish is reputed to have lost 64 square miles of land. Russell also described the steps of change from an island to a key to a submerged bar. He gave considerable evidence that the Chandeleur Islands are wasting rapidly and that a tongue of the delta formerly extended out to them. Breton Island was 11 miles long in 1870 and was 5 miles long in 1936. This chain of islands is also moving towards shore.

The area studied by Russell lies east of the river. Alluviation west of the river was arrested later and no such complete geological appraisal of the bay regions there has been published. However, this region is subjected to the same influence and there is general information that wasting has taken place. Russell (1948) terms

the whole process "abandonment of alluviation" and says it is far advanced in Terrebonne Parish. In 1932 a fisherman, who was then 65 years old, told the writer that the islands in Barataria Bay were washing away, that where large islands existed when he was a small boy there were now several small islands and furthermore that where several small islands formerly existed there now remained only an area of flats and shoal water. Reports of the Louisiana Department of Conservation state that the barrier islands at the mouths of the bays are wasting away. Fort Livingston on Grande Terre, an island at the mouth of Barataria Bay, had a large area of land in front of it when it was built by General Beauregard in the eighteen-forties. The land is gone now and the edge of the fort lies in the water. Little is left at Dernière Isle, which was a great pleasure resort in the first half of the nineteenth century. Comparison of old maps with recent ones show that large areas of coastal land have washed away in the past seventy-five years. Airplane photographs of Grand Terre show that the land which was a sugar plantation there in the nineteenth century is now invaded by salt water and has become marsh. Bassa Bassa Bay is increasing in size. Oysters are now growing in places on submerged tufts of marsh grass which could not have grown in the bay water; where the oysters now grow there was a marsh a few years ago. Round lakes are forming in the marshes to the north of the bays. Their formation is part of the erosion of the marsh. As sinking continues they will become contiguous with the bays. Authors, whose papers are restricted because of pending litigation, have observed remnants of the marsh (plant roots in clumps *in situ*) some distance out in the water from the present shore. The writer has observed the same thing in Vermilion Bay. It is also clear from the nature of the banks that the shores of Vermilion Bay are being cut. They are sharp or abrupt and pitted beneath the surface by undercutting. The same is true of White Lake and Grand Lake. No exceptions have been seen in an area covering several hundred square miles.

Grand Lake in southwest Louisiana has increased in size considerably since 1860. According to a report of the Corps of Engineers (1948, App. II, P. 3), "In general, all water bodies are now actively enlarging by wave attack and they provide evidence of a gradual loss of land within the marshlands. . . ."

Price (1933) presented evidence that there is a relationship between the width and depth of Gulf Coast bays. He extended this analysis later (Price, 1947) and advanced the theory that the basin depths are determined largely by scour action of wind-driven waves; the longer the sweep of the wind over the water, the higher the waves, the greater the scour action and the deeper the bays. Russell's (1936) observation that the deeper lakes and bays of the Louisiana Coast have sand bottoms, while the shallower ones have bottoms of silty ooze, is in agreement with this hypothesis. Russell noted that the "round lakes" forming in the Louisiana marshes grow slowly in size or little at all unless they have adequate outlets; lacking these the roiling of the water by the winds results only in redistribution of sediments.

The removal of islands within the bays will have the same effect on scour action as increasing the diameter of the bays, whether the actual bay diameters are increased or not, and the effect will be accelerated as the shoal areas are degraded. Therefore, we can expect a deepening of Louisiana bay waters, recently cut off from sedimentation by the levees, over and above deepening caused only by the rise

in sea level. Increasing salinity of the bays, at least in the depths, will result from the deepening bays and from wasting of the islands at the mouth of the bays. On the other hand, the last factor cannot be postulated with any certainty, for the barrier islands may move landward, just as the Chandeleur Chain is doing, in which case the passes would change in a fluctuating way, without definite trend. If the outlying islands move in as the upper marshy margins of the bays are eroded away, the north-south diameters may not greatly change. Nevertheless, wasting of the islands within the bays is changing the wind sweep-wave scour diameters and therefore deepening greater than would come about from sinking alone can be expected. This assumes, of course, that the disturbed sediments move out to sea. That such deepening has taken place is suggested by sediment studies of Barataria Bay by Krumbein and Aberdeen (1937) and Rasmussen and Lynch (1949). The latter authors have shown that between 1934 and 1947 a tongue of sand bottom extended up the center of the bay for about 3 miles from the mouth, where none existed before. They are of the opinion that the change is not seasonal.

The postulated deepening of the bays cannot be advanced for the mouth of the Atchafalaya, which is depositing more sediment than it did in the past. However, there may be less increase in sediment load at the mouth of the Atchafalaya than there would be expected from the increased water flow of recent years because about 60 miles below its source this river breaks up into a series of smaller channels and connecting lakes, which act as settling basins. Doubtless they have been filling rapidly in recent years and the sea has received less sediment than it would have otherwise. Nevertheless, as Russell (1948) has stated, one of the largest deltas in the world will eventually form at the mouth of the Atchafalaya.

If sinking of the Louisiana Coast or rise of sea level continues in concert with the "abandonment of alluviation" between the Mississippi and the Atchafalaya, it seems reasonable to expect that within time a large bay or sound will form between the two deltas.

In Atchafalaya Bay the salinity probably averages less than it did 60 years ago. In addition this area probably has a greater seasonal change of salinity than it had before the Atchafalaya River increased in size.

A salinity rise would be expected in the Terrebonne-Barataria Bay region, which in recent years has been only the drainage-way for the watershed between the levees of the Mississippi and Bayou Lafourche. This watershed is made up of large and small lakes, bayous, marshlands, and some lowland. It covers 1,915 square miles, is monotonously flat and covered with lush vegetation, so that little clastic sediment drains into the bay. The rainfall averages 60.0 inches per year and is fairly well distributed over the year. Compared to former years less fresh water enters the bays and there is less of a seasonal peak in the spring. The rapid spread of the "flottant" (*c.f.*, Russell, 1942) in the past fifty years has choked many waterways. This also has a tendency to slow the rate of drainage and reduce seasonal peaks.

A salinity rise in the bays would arise from two things, the cutting off of fresh water by the levees and the sinking coast. If, as a result of the sinking coast, the bays migrate inland, a change in salinity of the bays as a whole cannot be predicted. In that case the general salinity of the bays as a whole would not change, but with respect to any given point the salinity would rise and become ever higher. Further-

more, any recent sharp salinity change among the bays would have to be attributed to levees.

The vast Louisiana marshes are so close to sea level and their rising grade inland is so slight that the distance they will flood from the sea is probably determined by how far the water will run inland before the tide changes, rather than by the grade of the marsh. Tides raised above normal by winds flood the marshes for days along the whole coast. It is therefore, not expected that the intertidal zone of the Louisiana Coast will increase as the coast sinks. However, this zone will change location and move inland.

With the cutting off of the fresh water and sediments entering the estuarine waters near the river there was a parallel reduction in the nutrient salts brought down into the bays. Conversely there was an increase off the mouth of the Mississippi and in the Atchafalaya Bay region.

5. Evidence from the Oyster Industry that the Salinity of Certain Louisiana Bays Has Increased in Historic Times

The above remarks on salinity are based purely on a logical syllogism. In the absence of early salinity studies we would have little actual evidence for salinity changes, were it not for the oyster industry which has flourished on the Louisiana Coast for 45 years.

The American oyster, *Crassostrea virginica* (Gmelin), is an estuarine species. It flourishes best in waters between a salinity of approximately 15 and 30 *per mille.* At the higher salinities the Gulf oyster borer, *Thais haemostoma,* and other enemies which cannot tolerate a low salinity, prey on oysters and at times cause great damage. Apparently, the oyster could flourish in higher salinities than it does on the Louisiana Coast were it not for the conchs (*c.f.*, Burkenroad, 1931) and possibly other enemies. The important point for the present discussion is the fact that the oyster lives only in a relatively narrow strip of water of intermediate salinity along the coast line, between the danger of fresh water on the one hand and high salinity on the other. Therefore, when the salinity of the waters changes at a particular spot, the equilibrium of the oyster with this local environment is upset in various ways and some of the end results can be seen. Since the adult oyster is non-motile and oyster reefs are permanent fixtures, and since the oyster is commercially important, its fluctuations have been observed. Therefore, it is an indicator of salinity changes.

In the First Annual Report of the Oyster Commission of Louisiana (1904, p. 26) it is stated that formerly some of the best reefs in the state were in Jefferson Parish, but they had become unproductive. The Commission quoted the two explanations offered by the oystermen. One group maintained that the reefs were overworked and no spawning stock was left. The other said the water had become too salty. The Commission did not presume to judge the case, adding "but it is a fact that these once magnificent reefs show no disposition to become productive again."

In the Second Biennial Report of the Oyster Commission of Louisiana (1906, p. 17) it was stated that natural oyster conditions which formerly prevailed in lower Plaquemines Parish had been interfered with by "the continuous extension of the levee system, particularly on the east or left bank of the Mississippi River." It was

recommended that gaps in the levees be permitted at suitable intervals so that a flow of fresh water might mingle with salt waters of the Gulf. ". . . we believe . . . their construction would result in an immense increase in the crop of fat oysters; and oyster beds now extinct, which were productive many years ago, before the levee system was extended into that section, would once more become productive."

The following information and quotations are taken from the Report of the Board of Commissioners for the Protection of Birds, Game and Fish, State of Louisiana, 1912. Concerning Jefferson Parish it was stated, p. 25: "Barataria Bay, Bay des Islettes and Bay Tambour at one time contained large natural reefs, but these are now extinct." The cause of the destruction of the reefs was given as overfishing and increased salinity of the water due to improvement of the levee system.

"From observation it is found that the water favorable for oyster life is moving inland along the coast line of the Parishes of Jefferson, Lafourche and Terrebonne. This is due to artificial changes in the drainage system, levee improvements, closure of Bayou Lafourche and the washing away of the chain of outlying islands extending from Grand Island to Last Island. Oysters are now growing and leases have been made in waters of Lafourche and Terrebonne, which, six years ago, carried fresh waters at all times." (Ibid., p. 26.)

It was further stated, referring to Jefferson Parish again, that up to 1906 no oysters were planted or cultivated in Jefferson Parish due to the foregoing conditions. It was stated, however, that in 1926, under the direction of Messrs. Moore and Pope of the U. S. Bureau of Fisheries, 60 barrels of unculled oysters were planted at the upper end of Barataria Bay and Bayou St. Denis, resulting in the rehabilitation of the oyster industry in that bay. It was additionally stated that south of Bayou du Fon the water had become so salty and so infested with oyster drills that the fishermen had abandoned all claims in that area. "In order to rehabilitate this area, which is barren, it will be necessary to reduce the salinity or density of the water by fresh water from the Mississippi River." A lock at some point on the river was recommended.

The same report stated that the beds in Caminada Bay were extinct, and the beds in Timbalier Bay were practically extinct. It was stated that these beds were destroyed by overfishing and ravages of the "snail or borer," due to the closure of Bayou Lafourche. It was further stated that the principal beds in Lafourche Parish were located in Lake Raccourci, which six years ago was fresh water. The outlook for oyster culture in that parish was said not to be encouraging, unless "fresh water can be secured through Bayou Lafourche."

The report of the Conservation Commission of Louisiana (1914) reiterated the remarks concerning too much salt water over the oyster beds in Plaquemines Parish and the need for canals from the river. The localities affected were said to be California Bay and Quarantine Bay to the east of the river, and Bayou Cook, Bastian Bay, Grand Bayou and adjacent waters to the west of the river.

The same report stated that in the spring of 1912 all oysters in Jefferson Parish were destroyed by fresh water from the Hymedia Crevasse. This was said to be a blessing in disguise, however, for it destroyed the borer, *Thais*, "which had proved most destructive," and the salinity "was reduced to such an extent as to permit a heavy set of spat on shells of reefs." The report added that this crop alone would

be produced, for in the meantime the water would assume its usual salinity, which was of such density as to inhibit the setting of spat.

"No oysters have grown here (lower Barataria Bay, Bay des Islettes, Bay Tambour and Caminada Bay) since 1896, when water conditions were made similar by breaking of the Ames levee on the Mississippi River."

The same report repeated former statements concerning over-salinity in Lafourche Parish and recommended a lock at the head of Bayou Lafourche to alleviate the condition.

In the Report of the Conservation Commission of Louisiana (1916), Frank T. Payne, Chief Surveyor, stated that pursuant to Act No. 129 of the Legislature of 1914 he had surveyed Plaquemines Parish to find the most feasible locations for distribution of fresh water from the Mississippi River "into the oyster bearing bottoms of the parish which have been destroyed by the influx of salt water from the Gulf." The report added that the crop of oysters in Barataria Bay, brought about by crevasses along the Mississippi River, had been exhausted and since the waters of the bay had resumed their normal condition, "no future growth can be expected until fresh water is thrown into this section." A sum of $80,000.00 for locks in the river was recommended to let water into American, California and Quarantine bays, east of the river, and Grande Bayou, Cyprian and Barataria bays to the west.

The Fourth Biennial Report of the Department of Conservation, State of Louisiana (1920, p. 134) stated that oyster grounds in Plaquemines Parish "have been seriously affected of late years by storms and the influx of too much salt water. . . . Due to these causes many leases have been abandoned and their former owners have quit the business, . . ." It added that most of the water of that parish was too salty for the growth of young oysters but fine for fattening and to give flavor, and that oysters had not grown naturally at Bayou Cook for the past thirty years. Remarks concerning the inland movement of salt water and the growth of oysters in waters formerly fresh were repeated.

The following remarks about beds in Lafourche Parish were included in this report (p. 136): "Leases are located in the waters of Lake Raccourci, Bay Leau *(sic)* Douce, China Bay, Bay Creux, Bay Canard Gris and adjacent waters which, ten years ago, carried fresh water. All leases were made on barren bottoms, shells were planted, and the result has been large crops of fine marketable oysters."

The Sixth Biennial Report of the Department of Conservation (1924) reported that breaks in the levees benefited the oyster beds both east of the river and in Barataria Bay. The following remarks (p. 99) concerning the east bank crevasse are worth quoting: "The break in the levee at Poydras Plantation, about fifteen miles below the city, improved the oyster crop in some parts, although a large area of productive reefs were considerably affected. This, however, was only temporary for the oysters are now more prolific than ever. While the oysters near shore were destroyed by flood waters, the dead reefs located out in Chandeleur and Breton Island Sounds have benefitted, being now covered with oysters." The Department went on record as favoring spillways in the river because of the benefit they would have on the oyster industry.

In 1925 the New Orleans Levee Board started construction of the Bohemia Spillway and removed a section of 11 miles of levees between Bohemia and Bayou La Moque. In the Seventh Biennial Report of the Department of Conservation (1926, p. 52) the move was recommended because it would restore oyster beds "that become depleted

and non-productive, due to the encroachment of salt water caused by the cutting off of fresh water from the Mississippi River through extension of the present levee system."

The same report stated that topographic changes through the washing away of outlying islands permitted an influx of salt water to destroy large oyster reefs lying between these islands and the mainland shore. A survey of the dead reefs indicated that they contained 600,000,000 cubic yards of shell and it was stated that contracts had been let for commercial use of this shell, which would yield 7½c a cubic yard to the state treasury. This action implied that the Department of Conservation held little hope of rehabilitating the dead reefs.

The worst flood the State of Louisiana ever experienced was in 1927. This flood received considerable attention in the Eighth Biennial Report of the Department of Conservation (1928). Water from the Junior Crevasse killed oysters in Barataria Bay, but the greater part of the area was said to be "almost nonproductive" due to high salinity and the abundance of the "periwinkle." The damage is said to have been more than compensated by the fresh water, which allowed a heavy set of spat and killed the *Thais*. The net result was that reefs of Barataria Bay, "which have been barren for several years, show a heavy growth of young oysters, which will be ready for market about the first of 1929." (p. 184). It was added that the supply would be exhausted soon and would not be renewed when the customary salinity returned.

The Caernarvon Crevasse and the Bohemia Spillway east of the river caused great damage, but this was followed by "a very thick growth of young oysters in the flood affected areas. . . . Furthermore, the old, depleted and dead reefs in the outside waters between Point Chico and Point Comfort, from which no oysters have been taken in the history of the Conservation Department, are now completely covered with new growth." The last statement may have referred to the beginning of the Oyster Commission in 1902 or the the so-called Conservation Commission in 1912. The context is not clear.

In the Twelfth Biennial Report of the Department of Conservation (1936, p. 249) a mortality of oysters was reported in Plaquemines Parish due "in the opinion of this writer to a high-river until late in the summer, succeeded by a very sudden drop requiring the oysters to acclimate themselves very quickly to water of high salinity in the hot summer time. The large oysters seemed to be unable to acclimate themselves as rapidly as the younger ones and many died. There seemed to be, however, no unusual loss of the young oysters in the same beds."

The Fourteenth Biennial Report of the Department of Conservation (1940, p. 105) mentioned the continuance of the same peculiar mortality of the older oysters, saying that it had occurred for the past two years from the latter part of August to the first two weeks of October.

The Fifteenth Biennial Report of the Department of Conservation (1941, p. 115) mentioned the same loss of cultivated oysters in the parishes of Plaquemines and Jefferson. "A survey this year shows a loss in areas of high salinity ranging from 5 to 85 per cent of marketable counter oysters." The report went on to say that for the past several years the flow of the river has been under normal and "the finger of suspicion points to lack of fresh water as either the direct or indirect cause of the losses noted."

Enlarging upon this point (p. 129) the report says that since 1937 (it was first reported in 1936) a wave of mortality "strikes in the late summer through the beds of

West Plaquemines, Jefferson, Lafourche, and part of Terrebonne Parishes; in some instances as many as 80 per cent of the highly cultivated oysters on the best grounds have been killed." It was believed that a combination of three circumstances caused the trouble: 1. poor condition of the oysters at the end of the summer, 2. activity of the borers and other enemies, and 3. extreme saltiness of the water.[3]

It was stated that passes into the Gulf had widened and the Mississippi River had been low for the past 5 years. "The extreme saltiness for the past years has been progressive and since 1937 has very sharply increased."

It was reported that the Police Jury of Plaquemines Parish had conducted a survey to determine the quickest and most feasible way of obtaining additional river water for the oyster beds of that parish. The Louisiana Department of Public Works also conducted an investigation of the feasibility of flumes under the levees in Jefferson, St. Bernard and Plaquemines parishes. The Department of Conservation endorsed the move to get more river water over the oyster beds.

From the above reports it appears rather conclusive that the older oyster reefs in the lower bays have died out. That an increase in salinity was the direct or indirect cause is indicated by the fact that the reefs came to life again under the influence of the sudden influxes of fresh water from the crevasses. The establishment of oyster beds in the upper bays where none grew before and in areas which were fresh water a few years before, indicates in another way that salt water is moving inland. These observations supplement each other logically. Therefore, it seems safe to conclude that the salinity of Terrebonne, Timbalier, Barataria bays, and adjoining smaller bodies of water on the Louisiana Coast has been increasing for some 45 years or so and probably more. This process seems to have been gradual. The influence of this change upon the organisms of the area has doubtless been great, as we have indicated above, but they have not been recorded except in a very general way for oysters.

There is evidence of an entirely different sort that the environments of the bays of Louisiana and possibly Texas a few thousand years ago were different from what they are today. For the past fifty years or so the Texas bays have been the source of material known as "mudshell." It is dredged up from layers in the bottom of the bays, where it is covered over with mud. The dredges frequently operate down to a depth of twenty-five feet below the surface of the bottom and it is known that some of the deposits extend several feet deeper. The material is almost pure oyster shell, with very little admixture of other species. It is commercially valuable as a source of almost pure calcium carbonate and as a road material. The reports on time when mudshell dredging began, the maps of old reefs now dredged up, and production records, especially in earlier years, are not very exact or are missing entirely. Nevertheless, millions of cubic yards of this material have been dredged from Texas bays in the last thirty years. The size of the mudshell industry is indicated by the fact that during some of the recent war years the collection of a severance tax by the Texas Game, Fish and Oyster Commission at the rate of 5 cents per cubic yard amounted to over 1,000,000 dollars per annum.

In contrast, in Louisiana half or more of the mudshell dredged from Louisana bays consists of clam shells of the species *Rangia cuneata,* which apparently never grew

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[3]It should be pointed out that the causes of these mortalities were not determined but that they coincide in general characteristics with mortalities said to be caused by *Dermocystidium marinum,* of which Mackin (1951, p. 86) says: "Under conditions of high temperature and high salinity massive infections develop, . . ."

in great abundance in Texas. The Point au Fer reef off the mouth of the Atchafalaya River produces considerable amounts of oyster shell. The clam is tolerant of much lower salinities than the oyster and is found growing in water that is nearly fresh. Therefore the shells from dead reefs are not mixtures, but are composed of one mollusk or the other. In Bay Chene Fleur shells of *Rangia* form the substratum of private oyster reefs. Mr. M. D. Burkenroad has pointed out to me that Indian kitchen middens along Bayou Robinson, in present oyster country, show consumption of *Rangia* but none of oysters.

The known large oyster shell deposits of Louisiana lie in the lower bays. Today Louisiana is the home *par excellence* of the oyster and production there equals the production of the remainder of the Gulf Coast, exceeding a million barrels in some years (Gunter, 1949). The Texas Coast has never equalled this production and the maximum year has been less than one-fifth of Louisiana's maximum. The mudshell deposits of the Texas Coast extend back to at least 25,000 years and possibly longer. However, whether or not the environment of the Texas coast has changed is problematical, for Texas had some large oyster reefs up until recent years. In the case of Louisiana, there is clear indication that the distribution of fresh and salt water has changed sharply, and this may have been very recent. In fact it probably came with the appearance of the white man and the levees.

6. Effect of Changes in the Coast on Marine Life

In summary, the following things have happened to certain large estuarine areas on the Louisiana Coast. Alluviation, sedimentation and the influx of river flood waters in the spring have ceased. This probably lowered the amount of nutrient salts draining from land. In addition the salinity has been raised for given points and probably somewhat stabilized with a lessening of the spring peaks of flood waters. With the cessation of alluviation, the islands within the bays are eroding away under the influence of the sinking coast and the bays are becoming deeper. The bays themselves will probably move inland as the coast retreats. How much the influx of sediments, fresh water and nutrient salts changed and what changes in the estuarine fauna and flora resulted is not known.

Certain general changes that have taken place in the fauna can be predicted with some surety. The cessation of sedimentation from land might cause considerable change on life in the bays. Oysters are forever combating silting and the stress of this factor would be somewhat lessened for them. However, if the central portion of the bays become sandy, with increasing depth, oysters will not be able to live there any more. The white or lake shrimp does not prefer sandy bottoms, and would retreat to the areas of mud. Other unknown changes among the mud dwellers would take place. In the Atchafalaya Bay region the situation would be reversed.

The Mississippi carries an estimated 785,190,000 cubic yards of water a year into the Gulf. Figures given by Clarke (1924) indicate that about 3.1 parts per million by weight is combined nitrates and phosphates. This is equivalent to 220,507 tons of nutrient salts a year. These figures need checking by further determinations but the amount is large in any event and there is little wonder that Riley (1937) found that the Mississippi exerted a great influence on the fertility of the adjacent area of the Gulf. The Barataria-Terrebonne bay region has lost in these materials and the Atchafalaya

Bay region has gained. This tendency may be somewhat nullified by influx of nutrients from the sea.

Small white or lake shrimp, *Penaeus setiferus* (Linnnaeus), grow in brackish waters and the young, hatched at sea, must enter these waters or perish (Weymouth, Lindner and Anderson, 1931). Possibly the well-known shrimp productive capacity of the Morgan City area of the Louisiana Coast is a partial result of increased fertility of the region due to the increased flow of the Atchafalaya River.

Bay and estuarine areas are nursery grounds for many species of marine animals, but they are not nursery grounds alone; many animals are indigenous to estuarine areas. Most species living in these waters have definite salinity limits on the lower side (Gunter, 1945, 1950). The motile organisms in the Louisiana bays can move in or out with salinity changes and even the sedentary species will in succeeding generations move inland with increasing salinities.

Several oyster reefs seem to have been wiped out by rising salinity, as noted above. These effects may be indirect, in that high salinity exposes the oysters to attacks of *Cliona, Polydora, Martesia, Menippe, Thais, Dermocystidium* and other pests. In other cases effects may be direct when the salinity becomes too high for *Rangia, Brachidontes* and other species. Salinity increases are gradual and similar to climatic changes. They fluctuate from season to season and from year to year, but the maxima and minima become higher at a given point. Therefore, the large Louisiana oyster industry exists in a situation which is not at equilibrium. The evidence points to an inexorable encroachment of saltier water. Some oystermen have attempted to continue in areas where oysters can no longer be raised. Instead they must move inland and abandon their claims, just as plantation owners have had to do when their land turned to marsh.

In contrast, the Point au Fer reef in Atchafalaya Bay, the largest reef in the State, was killed by fresh water and some wild oysters are now growing outside of the bay in the open Gulf of Mexico. The condition seems to be one of too much fresh water for oysters in this region.

Russell and Russell (1939) have shown that the deltaic deposits at the mouth of the Mississippi are partly interlaid with marine deposits. Similarly, the writer has recently found old oyster shells mixed with living *Rangia* in White Lake, demonstrating fluctuating salinities. Thus we may look upon the encroachment of the sea in the Louisiana bays as a temporary triumph over the counter process of alluviation, and a transient phase geologically. In this case, however, if man has his way with the Mississippi River the process will not be soon reversed.

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Actiniaria, Zoantharia and Ceriantharia from Shallow Water in the Northwestern Gulf of Mexico

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INTRODUCTION

This paper is based on long distance collaboration between the authors. Hedgpeth has in the main collected the material and made sketches of the anemones in life and provided notes about the exterior and natural history of the animals. Carlgren has determined the species and in the main prepared the anatomical descriptions and histological drawings.

The collection of anemones from Texas and Louisiana described in this paper consists of material collected from shore and shallow water in Texas by the junior author in the Rockport, Port Aransas and Port Isabel areas, together with material from other localities donated by various collectors. Whenever possible the living material was studied and the nematocysts examined. In all, fifteen identifiable species have been found in the region, thirteen actiniarians, one zoanthid and one ceriantharian, as follows:

Andwakia isabellae n. sp.
Bunodosoma cavernata (Bosc).
Anemonia sargassensis Hargitt
Anthopleura krebsi (Duch. et Mich.)
Bunodactis texaensis n. sp.
Bunodactis sp.
Minyas olivacea (Lesueur)
Paranthus rapiformis (Lesueur)
Calliactis tricolor (Lesueur)
Bartholomea annulata (Lesueur)
Aiptasia pallida (Verrill)
Aiptasiomorpha luciae (Verrill)
Aiptasiomorpha texaensis n. sp.
Botryon tuberculatus n. g., n. sp.
Palythoa texaensis n. sp.
Ceriantheomorphe brasiliensis Carlgren

Although it is possible that more species occur in the shallow waters along the Texas coast, the actinian fauna is evidently poor in comparison with the rich fauna of the Antilles. Louisiana waters are probably even more impoverished, and it is to be noted that only four anemones and a cerianthid have been previously reported from that region (Cary, 1906).

The Corallimorpharia and benthic stichodactyline Actiniaria are completely lacking from the northwestern Gulf of Mexico, as well as representatives of the families Aliciidae and Boloceroididae. Only one species of Zoantharia, which are numerous on the coasts of the West Indies, is found in the waters of Texas. It must be emphasized that these remarks apply to the coastal waters proper; the occurrence of living coral patches on small topographic features near the 100 fathom line suggests that some of the typical West Indian forms may be found on these elevations, some of which rise to within 10 fathoms of the surface. Close inshore, there is but one living madreporarian coral, *Astrangia astreiformis* Milne Edwards and Haime, occurring in small clumps in the deeper parts of the bays near the passes along the Texas coast and in the shallow Gulf. Two alcyonarians, *Renilla mülleri* Kölliker and *Leptogorgia setacea* (Pallas) are common in relatively shallow water in the Gulf along the shore, and a third, *Virgularia mirabilis* (O. F. Müller), occurs occasionally.[1]

The poverty of the actinian fauna in the northwestern Gulf of Mexico can be attributed to several factors. Hard or rocky substrates are lacking, except for the jetties at the passes and the stonework of the bay harbors, pilings, and shell reefs. These offer at best an insignificant opportunity for the development of a rich actinian

[1]We are indebted to Dr. Elisabeth Deichmann for identification of these alcyonarians.

fauna. Furthermore, the temperature and salinity along the shore, especially near the passes where most of the collecting has been done, and in the bays, is quite variable (see Whitten, Rosene and Hedgpeth, 1950, and Collier and Hedgpeth, 1950); this range of environmental conditions limits the fauna to a few comparatively hardy species.

The actinian fauna of the northwestern Gulf of Mexico is predominantly temperate or possibly warm-temperate in its affinities, with a number of tropical strays. Of the thirteen actinians represented in this collection, two occur as far northward as Woods Hole, three northward to Cape Hatteras (one of these has not been found in tropical Florida waters), four are West Indian forms whose northernmost range is Texas or Louisiana, and four species are new, possibly endemic. The remaining species is the ubiquitous *Aiptasiomorpha luciae,* which on the basis of its known distribution can be expected to turn up almost anywhere except the tropics. The characteristic jetty form, found both on the jetties of passes and the harbor works of the bays, *Bunodosoma cavernata,* is a West Indian species ranging as far north as Beaufort, North Carolina. Two species, *Anemonia sargassensis* and *Bartholomea annulata,* are carried to the shore on sargassum, the former as far north as Woods Hole, but these are only accidental guests which do not live long enough to develop new populations. One species, *Minyas olivacea* is pelagic, bearing a float at its aboral end. Among the new and possibly endemic species the most noteworthy is the curious *Botryon tuberculatus.* A small, inconspicuous species, *Aiptasiomorpha texaensis,* is of interest since it appears to be a *bona fide* estuarine species, similar in that respect to *Diadumente schilleriana* of the Ganges Delta region. The occurrence of *Aiptasiomorpha luciae* at Port Aransas during the winter of 1947–48 adds still another locality to the itinerary of this wandering species, which is found at Woods Hole, Beaufort, along the Central California coast, in Japan, the Suez Canal and many other regions. It may not, however, be a naturalized member of the fauna, and its presence in 1948 may have been the sequel to the shipment of a barrel of oysters to Port Aransas from New Jersey for experimental purposes a few months before, or it may have travelled from Delaware to Port Aransas as a fouling organism on the oil tankers which regularly ply between the loading docks at Port Aransas and the refineries at Wilmington. Such circumstances may also account for some of the boreal hydroids on the Texas coast considered by Deevey (1950) as glacial relicts.

Many of the individual anemones are small, an indication, perhaps, of the influence of environmental extremes. According to Coe (1951), the nemerteans of the northern Gulf of Mexico are generally smaller than the northern representatives of the same species. In the case of the actinians, which are for the most part the northernmost representatives of warmer water species, the suggestion that they are smaller representatives of forms which are larger in colder waters cannot apply, and the question of size in relation to temperature is obviously more a matter of the optimum for the species concerned rather than of the temperature conditions *per se.* Picard and Le Roch (1949), have observed a reduction in general size of anemones in waters of reduced salinity along the shore of the northern Mediterranean as compared with those in the sea nearby, and speak of them as "dwarfed forms."

More information is necessary before such a generalization may be safely made about the actinians of the Texas and Louisiana coast; few species are found both in the bays and in the nearby Gulf, and there are too many factors acting upon the life

on the jetties along the channel for us to separate these variables without experimentation. One possible example of environmental differences is that presented by *Aiptasia pallida* which occurs offshore near Port Isabel and in South Bay. The South Bay forms appear to be somewhat larger, and are brown, whereas the representatives in the Gulf are very pale blue and generally smaller. In South Bay salinities may be somewhat higher than in the Gulf, but temperatures are also higher, and the food supply is probably greatly different.

KEY TO THE SPECIES

Unfortunately it is not possible to construct a key to anemones which can be used in the field; a few can be determined, in a limited area, on the basis of external characters, but determination of most species requires the examination of prepared sections and of the nematocysts. The latter are best examined in freshly macerated material. The various types of nematocysts to be expected in the species known from Texas and Louisiana are indicated in Figure 1. In the following key, diagnoses are provided for several species which are not completely characterized in the systematic part of this paper.[2]

I. Tentacles in several cycles, the inner cycles larger; *b*-mastigophors and holotrichs lacking or rare; usually with well developed base and contractile column ..... ACTINIARIA
Tentacles arranged in two cycles on the margin, or if in several cycles, the outermost largest ..... II.

II. Small polyps without marked pedal disc; solitary or connected by a coenenchyme; column wall usually thick, slightly contractile; with *p* and *b*-mastigophors and holotrichs ..... ZOANTHARIA
Column wall comparatively thin, strongly contractile; column without pedal disc but with a terminal pore; *b*-mastigophors and hoplotelic *b*-mastigophores present, *p*-mastigophors absent; burrowing forms ..... CERIANTHARIA

I ACTINIARIA

1. Species with distinct basal disc and basilar muscles 2
With rounded basal end, without basilar muscles; column divisible into physa, scapus and scapulus; scapus with distinct tenaculi; sphincter mesogleal; 2 siphonoglyphs and 2 pairs of directives; 24 pairs of mesenteries, 6 of which are perfect; retractors strong on the perfect mesenteries, restricted to circumscribed on others and lacking pennons; acontia on at least some of the mesenteries ..... *Andwakia isabellae*
2. Species without acontia 3
Acontia present 8
3. With marginal spherules, usually containing atrichs, rarely lacking; lower part of the column often with atrichs 4
Without marginal spherules 6
4. Column with rows on non-adhesive vesicles or adhesive verrucae 5
Column smooth, low; sphincter diffuse, not strong; tentacles variable in number, up to 40–50, often irregularly arranged; 2 or no siphonoglyphs; 2 directives or none; arrangement of the mesenteries often irregular as a result of asexual reproduction, or regular; retractors of the mesenteries diffuse ..... *Anemonia sargassensis*

[2]For descriptions of the anatomy of sea anemones, see Hyman, L., The Invertebrates, Vol. I, Protozoa through Ctenophora (McGraw Hill, 1940), p. 566 ff., and Stephenson, T. A., The British Sea Anemones (Ray Society, 1928), Vol. I.

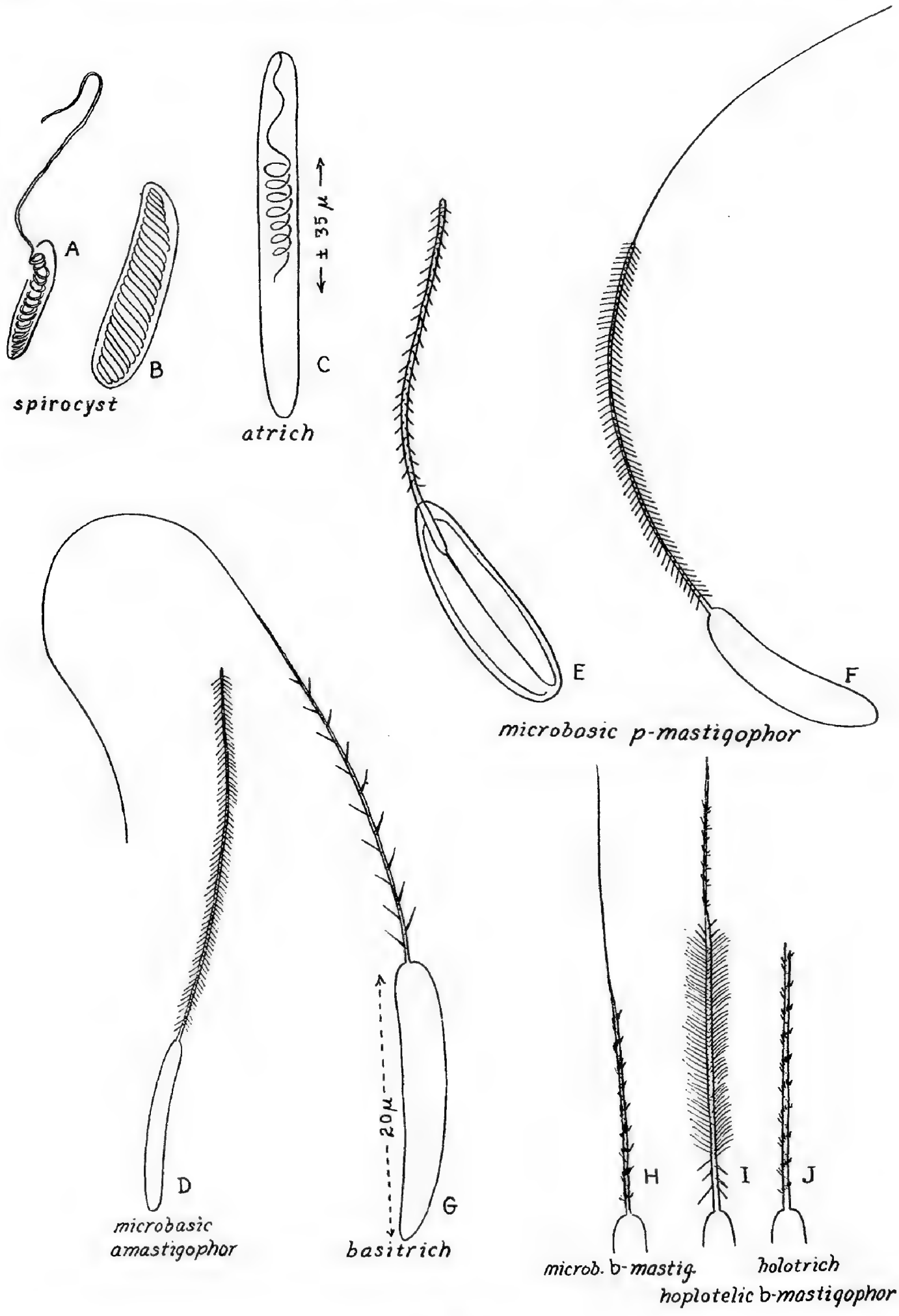

FIGURE 1

Types of nematocysts found in the species described in this paper: A, B, spirocysts, ruptured and unexploded, from *Paranthus rapiformis*. C, partly unexploded atrich, from *Ceriantheomorphe brasiliensis* (After Carlgren, 1940). D, microbasic amastigophor, from *Aiptasia pallida*. E, F, microbasic *p*-mastigophor, *Aiptasiomorpha luciae*, partially and completely exploded. G, basitrich, from *Bunodactis texaensis*. H, microbasic b-mastigophor; I, hoplotelic b-mastigophor. J, holotrich (H, I, J, diagrammatic).

5. Entire column provided with rows of (non-adhesive) vesicles; sphincter circumscribed, strong; tentacles rather short, up to 96; 2 distinct siphonoglyphs and 2 pairs of directives; most of the mesenteries perfect and fertile ..... *Bunodosoma cavernata*

   Column provided with rows of adhesive verrucae; sphincter circumscribed, weak; tentacles rather short, not numerous; arrangement of the mesenteries irregular, owing to longitudinal fission ..... *Anthopleura krebsi*

6. Without adhesive verrucae on the column 7

   Column with rows of adhesive verrucae; sphincter circumscribed; tentacles cyclically arranged, up to 96 in number; 2 siphonoglyphs and 2 pairs of directives; 24 pairs of perfect mesenteries; all stronger mesenteries fertile ..... *Bunodactis texaensis*

7. Body melon shaped, with 20 longitudinal furrows; pedal disc invaginated, so that an opening is visible in the aboral end, the cavity of the aboral end containing a structure forming a hydrostatic apparatus; sphincter circumscribed, very weak; tentacles papilliform, arranged in radial series; one spihonoglyph and two pairs of directives; arrangement of the mesenteries different from the common scheme because of an enlargement of the endocoels and reduction of the exocoels, giving the appearance of many directive pairs; retractors strong .... *Minyas olivacea*

   Body elongate, smooth; sphincter mesogleal; tentacles rather short, more numerous than the mesenteries at the base; 2 siphonoglyphs, 2 pairs of directives; at least 12 cycles of mesenteries perfect in fertile specimens; retractors of the mesenteries strong ..... *Paranthus rapiformis*

8. Acontia bearing two types of nematocysts 9

   Acontia bearing only basitrichs; column with an annulus of cinclides near the base; sphincter strong, mesogleal; tentacles up to 96 in number; 2 siphonoglyphs and 2 pairs directives; 6 pairs of perfect and fertile mesenteries; retractors weak, diffuse ..... *Calliactis tricolor*

9. Acontia with microbasic *p*-mastigophors and basitrichs; cinclides present 10

   Acontia with microbasic amastigophors (?) and basitrichs; cinclides absent; at least 12 pairs of perfect mesenteries; column with longitudinal rows of mesogleal papillae more or less regularly arranged; all or almost all mesenteries fertile, the male organs (at least) forming botryoid clusters ..... *Botryon tuberculatus*

10. With mesogleal sphincter; column smooth, regular, not divisible into scapus and capitulum 11

    Without sphincter; column divisible—or apparently so—into scapus and capitulum 12

11. Sphincter rather well developed; tentacles long, not retractile, smooth, up to 96 in number; 6 pairs of perfect mesenteries; 2 sinhonoglyphs and 2 pairs of directives; retractors of the perfect mesenteries diffuse or restricted; cinclides in middle part of the column; reproduction by laceration (constriction) ..... *Aiptasia pallida*

    Sphincter not strong; tentacles long, not retractile, considerably more than 96 in full grown individuals, bearing raised bands of nematocyst batteries; 6–8 pairs of perfect mesenteries ..... *Bartholomea annulata*

12. Column divisible into scapus and capitulum, the former ending in a very distinct parapet; cinclides present from parapet to base; tentacles long, irregularly arranged; number of siphonoglyphs and directive mesenteries as well as perfect mesenteries variable owing to reproduction by longitudinal fission ..... *Aiptasiomorpha luciae*

    Column apparently divisible into scapus and capitulum; cinclides in a ring in the middle of the column; sphincter apparently absent; tentacles long, few, probably not retractile; 2 siphonoglyphs and 2 pairs of directives; 6 pairs of perfect and fertile mesenteries; reproduction probably by laceration ..... *Aiptasiomorpha texaensis*

II. ZOANTHARIA

Free polyps; column incrusted with grains of sand occupying the whole mesoglea; divisible into scapus and scapulus, the scapular ridges distinct; sphincter mesogleal; tentacles 28, arranged in two cycles; one siphonoglyph; 28 mesenteries ..... *Palythoa texaensis*

III. CERIANTHARIA

Column cylindrical, its aboral end rounded, with a strong longitudinal muscle layer; tentacles in several cycles, partly at the margin, partly at the mouth; one siphonoglyph and one pair of directives; directive mesenteries rather short, also the third protomesenteries; second protomesenteries long, reaching almost to the aboral end, provided with craspedonemes on the orthocraspedon (ciliated streaks), in almost their whole length, and a small plectocraspedon (cnidoglandular streak) in their aboral end; older metamesenteries 1 and 3 (M and m) in each quartette somewhat longer than the directives, with craspedonemes forming a bunch in the lowest part close to the plectocraspedon; matamesenteries 2 and 4 (B and b) shorter than the directives, their orthocraspedon often with craspedonemes, but not forming the clusters at the plectocraspedon; all mesenteries, except the directives, fertile ..... *Cerianthemorphe brasiliensis*

SYSTEMATIC DISCUSSION

ORDER ACTINIARIA

Family ANDWAKIIDAE

Andwakia isabellae n. sp.

Figure 2, A-E

Material examined: Off Port Aransas, Texas, May 18, 1933. K. H. Mosher, coll., 1 specimen (no other data) (Paratype, U.S.N.M. No. 49981). Off Port Isabel, in about ten fathoms, sandy bottom, with try net, March 30, 1947, J. Hedgpeth, coll., 1 specimen (Holotype, U. C. N. M. No. 49982).[3]

Description: The base is apparently rounded, but from the available material it is not possible to be certain that basilar muscles are absent, although they appear to be lacking. The column is divisible into scapus and scapulus, the former provided with numerous well developed tenaculi. The sphincter is mesogleal, reticular, occupying a part of the mesoglea, but owing to the inadequate material cannot be adequately figured. The tentacles are arranged in 4 cycles, thus 48 in numbers (observation by Hedgpeth). They are very small in comparison to the size of the animals and their longitudinal muscles ectodermal, palisade-like in arrangement. There are two well developed siphonoglyphs. The pairs of mesenteries are $6 + 6 + 12 = 24$; two pairs are directives and six pairs are perfect. The retractors of the perfect mesenteries are very strong, strongly restricted to circumscribed in cross section (Fig. 2, C and E), the longitudinal muscles of the other mesenteries form no pennons, but are rather well developed (Fig. 2, D). The parietal muscles of the perfect mesenteries resemble the muscles of the imperfect mesenteries. All mesenteries are provided with filaments and at least a part of them with acontia. Owing to the smallness of the other mesenteries, it is probable that only the perfect mesenteries bear generative organs. The

[3]"Material examined" indicates the material sent to Sweden to be examined by the senior author; in some cases, as indicated in the text, more material was collected.

nematocysts of the scapulus are microbasic *p*-mastigophors or amastigophors, often curved, 19.7–24 (26.8) x 4.2–5.6 μ; those of the tentacles, basitrichs, 21–28.2 x 2.8 μ; those of the actinopharynx partly basitrichs, 24.7–32.4 x 2.8 μ (25.4–31 x 2.5–3 μ): partly amastigophors (probably), 25.9–33.8 x 5.6–7 (8.5) μ, (28.2–33.8 x 5.6–7 μ); of the filaments partly basitrichs, 8.5–15.5 x 1.5–2.2 μ (12.7–15.5 x 2 μ), partly microbasic *p*-mastigophors (13.4–17 x 3.5–4.5 μ); of the acontia partly basitrichs, 15.5–21 x2.2–2.5 μ, partly microbasic amastigophors or *p*-mastigophors, 42.3–48 x 8.5–10μ. (The measurements in parentheses are from the specimen from Port Isabel.)

The specimen from Port Isabel (expanded) is 8.5 cm. long, the largest diameter 2.5 cm., the tentacles 1 cm. long; the contracted specimen from Port Aransas is 7 cm. by 3.2 cm.

Color: Oral disc gray, with darker zigzag markings, darker markings at the base of the tentacles and on the tentacles (see Figure 2, B).

Remarks: Unfortunately both samples as sent to Sweden were previously dissected, and owing to the poor condition of the basal part it is difficult to decide whether the specimens belong to *Andwakia* or *Epiphellia*, but as the basilar muscles are apparently absent the specimens may at present be referred to *Andwakia*.

Family ACTINIIDAE

Bunodosoma cavernata (Bosc)

Plate I; Figure 2, F–H.

Bunodes cavernata Bosc, 1802, p. 22.
Actinia granulifera Lesueur, 1817, p. 173.
Phymactis cavernata Andres, 1883, p. 448; Field, 1949, p. 10.
Bundosoma granulifera Duerden, 1902, p. 348; Pax, 1910, p. 184; Carlgren, 1949, p. 51.
Bunodosoma cavernata Carlgren, 1949, p. 51; Whitten, Rosene and Hedgpeth, 1950, p. 94.

Material examined: Port Aransas, Texas, rocks near jetty at low tide 3 specimens; Port Isabel, Texas, 2 specimens (One, very large), from ship channel, sandy-muddy bottom, about 25 feet. March 15, J. W. Hedgpeth, coll.

Description: The pedal disc is well developed. The entire column is provided with very close set vesicles. At the margin there is an annulus of spherules (rarely absent, as in the young specimen from Port Isabel). The sphincter is circumscribed, agreeing well with the sphincter of *granulifera* figured by McMurrich (1889, Pl. III, fig. 7) and Duerden (1902, Pl. IX, fig. 34). In the large specimen it is of the same type but broader, and the muscle lamellae are very numerous (Figure 2, F). The tentacles are rather short and up to about 96 in number. There are two siphonoglyphs and two pairs of directives. The retractors are band-like and the parietobasilar muscles well developed. The nematocysts of the lower part of the column, the marginal spherules and the tentacles in the three small examples from Port Aransas and of the other organs in one specimen from the same locality have been examined. The nematocysts of the lower part of the column are partly basitrichs, 12.7–21 x 2.2–8 μ, partly atrichs, 18.3–22.6 x 4–4.5 μ; of the marginal spherules, atrichs, 33.8–46.5 x 4.2–5μ; of the tentacles, basitrichs 15.5–19.7 x 2.2–2.8 (3 specimens examined); of the actinopharynx, partly microbasic *p*-mastigophors, 17–19 x ca. 4.2 μ, basitrichs, partly 12–22.6 x 2.2–3 μ; of

the filaments, partly microbasic *p*-mastigophors, 18.3–20.4 x 4.5 μ, partly basitrichs, 24–35.2 x 4.5–6.3 and 12.7–15.5 x 2.2–3 μ.

In the very large specimen from Port Isabel the nematocysts of the lower part of the column and tentacles are larger. in the column, partly basitrichs (sparse), 18.3–

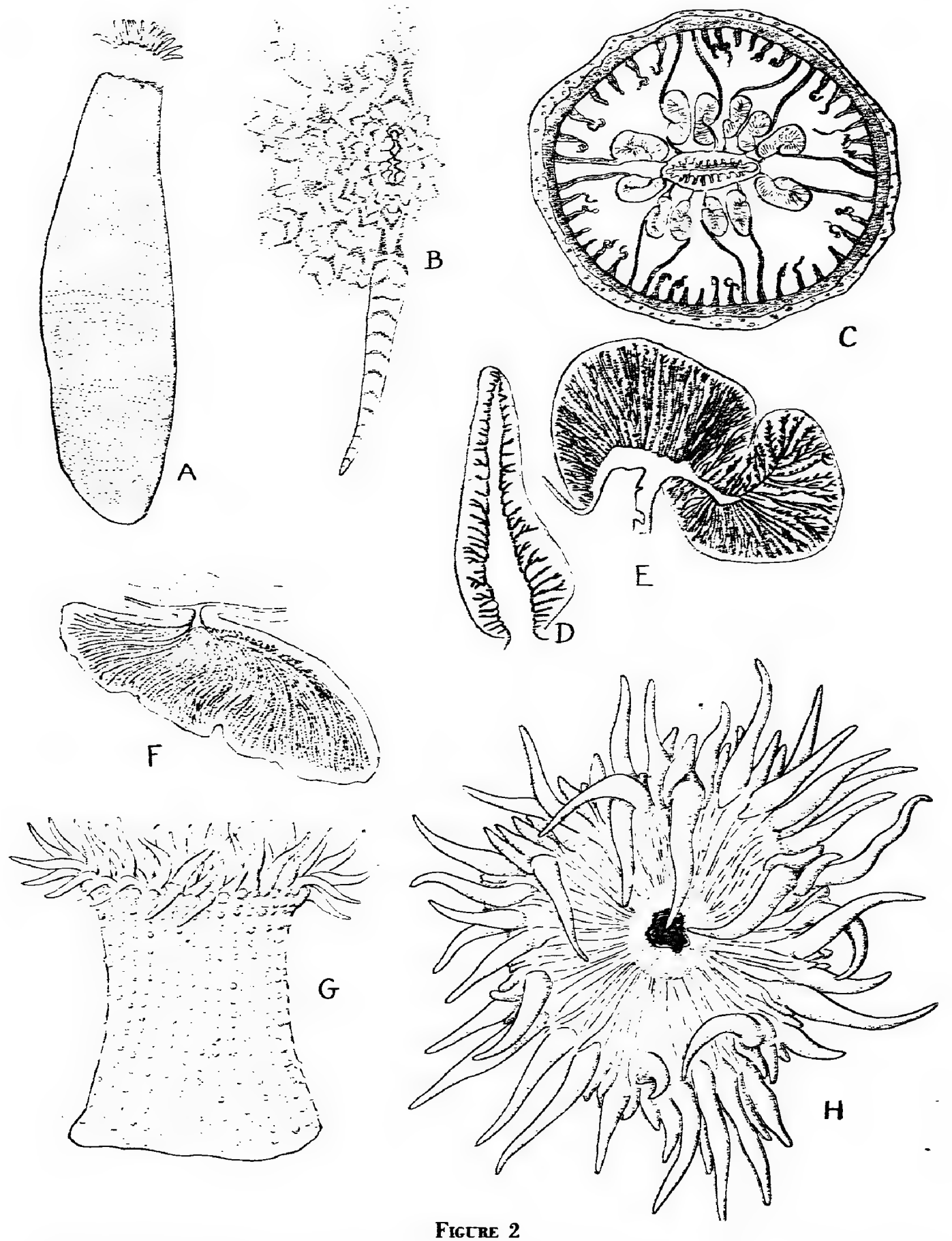

FIGURE 2

A–E: *Andwakia isabellae*, n. sp.; A, sketch of living specimen from near Port Isabel; B, portion of disc of same; C, cross section of specimen from near Port Aransas; D, imperfect mesentery; E, retractor muscle. F–H: *Bunodosoma cavernata* (Bosc); F, sphincter of large specimen from Port Isabel; G, sketch of living individual from Port Aransas: H, oral view of specimen from Port Isabel.

25.2 x 2.8–3 μ, partly larger basitrichs?, probably atrichs (very rare), 31–36 x 4.2–6.5 μ; in the marginal spherules atrichs, 31-42.3 x 3.5–5 μ; in the tentacles basitrichs, 18.3–26.8 x 2.8 μ; in the actinopharynx partly microbasic *p*-mastigophors, 21–24 x 5.5 μ, partly basitrichs of probably two sorts, 14–28.2 x 2.5–4.2 μ, in the filaments partly microbasic *p*-mastigophors, 18.3–24 x 4.2–6.3 μ, partly basitrichs, 21–42.3 x 3–7 μ (also smaller basitrichs, not measured). It might appear that we are dealing with two different species, but this is probably not the case. In two specimens of medium size from Beaufort the basitrichs in the lower part of the column and in the tentacles are up to 24–25.4 μ long, although the largest ones are sparse. Evidently the basitrichs may be larger with the increasing age of the species. The number of atrichs in the lower part of the body varies considerably, from very numerous to very rare.

Color: Light brown with bluish vesicles, tentacles and oral disc from deep red and blue to pale olive-brown. The color of Texas jetty specimens agrees well with notes provided by T. A. Stephenson for *B. cavernata* at Beaufort: "There are sometimes more or less definite blue shades on the oral faces of the tentacles especially on the outer ones and the aboral sides of the tentacles may be red." A sample from Port Isabel had the column olive-green, the oral disc yellowish olive-green and the marginal spherules dull tan-green. Another sample, the largest, from the bottom of a muddy-sandy channel, was entirely muddy-brown. Other specimens, from the Port Isabel jetties show agreement with those of *granulifera* described by Duerden, a vaguely striped appearance of the column, the dull cream or yellowish tentacles and a scarlet rim around the mouth. Evidently the color of the species varies considerably.

Remarks: From the agreement of the color and of the sphincter, etc., it is apparent that *cavernata* and *granulifera* are the same species. Some variations of the sphincter are discussed in another paper (Carlgren, 1952, p. 2).

Distribution: Bahamas, Puerto Rico, Jamaica, Barbados, Guadeloupe, Martinique, St. Thomas, Curaçao, in the West Indies; on the Atlantic coast from north Florida to Cape Hatteras; on the northwestern Gulf Coast at Port Isabel, Port Aransas, Rockport, Texas and Cameron, Louisiana.

Anemonia sargassensis Hargitt

Plate IV; Figure 3, A-D.

Anemonia sargassensis Hargitt, 1908, p. 117; 1914, p. 239, Pl. LI, fig. 3, Pl. XLIV, fig. 3; Field, 1949, p. 9, Pl. IV, figs. 38–41, Pl. V, figs. 42–46.

Material examined: From sargassum, St. Joseph Island, Texas, April 8, 1946, several specimens. J. W. Hedgpeth, coll.

The anatomy of this species is described by Field (1949) but there are several details which may be corrected and completed at this time.[4] The pedal disc is well developed, the body, at least in contracted state, low, short. The column is smooth, at the margin provided with spherules "protuberances from the periphery of the oral [!] disc"—Field), which, however, are rather weak. The sphincter is diffuse, not strong (Fig. 3, D). The tentacles are rough, the inner considerably stronger than the small outer ones, but as the arrangement is irregular, small tentacles occurring between the larger, their number is up to 40–50. The longitudinal muscles of the tentacles and the

[4]For further comments on the paper by Field, see T. A. and Anne Stephenson, 1952, pp. 34–35, and Carlgren, 1952, p. 16.

radial muscles or the oral disc are ectodermal. The siphonoglyphs, if present, are weak. Unfortunately the actinopharynx of two sectioned specimens is very folded, so that it is difficult to make out the number of the siphonoglyphs, but there are several furrows with somewhat stronger cilia, possibly indicating the presence of siphonoglyphs. Field has indicated (in figure 38) two siphonoglyphs, but as the sections were taken in the region of the tentacles it is very doubtful that there were any siphonoglyphs in her specimen. Hargitt figures, however, a young specimen with two siphonoglyphs and two pairs

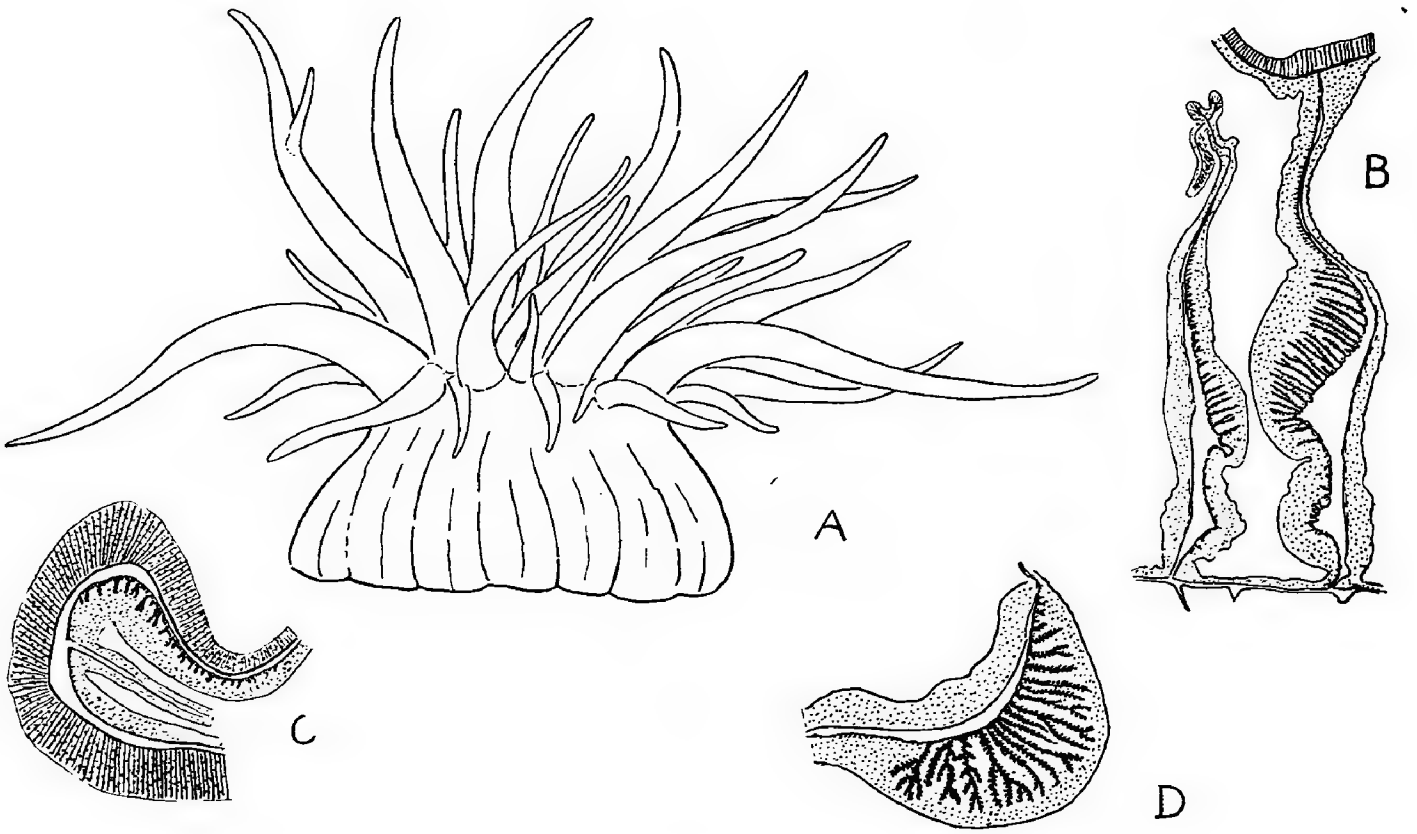

FIGURE 3

Anemonia sargassensis Hargitt: A, sketch of living individual; B, transverse section through two mesenteries; C, sphincter; D, retractor from perfect mesentery.

of directives. Neither in Field's nor our specimens were directive mesenteries present. Evidently the species propagates asexually, probably by longitudinal fission. Two examined specimens had 9 and 12½ pairs of perfect mesenteries respectively. Field says that there are 24 perfect pairs at the oral end of the actinopharynx; her figure 38 shows, however, apparently 11 pairs of perfect mesenteries. The retractors are diffuse (Figure 3, D). No gonads are developed in the two sectioned samples. There are considerably more mesenteries at the base than at the margin. The nematocysts of the column are basitrichs, 15.5–19.7 x 2.2–2.8 μ; those of the marginal spherules partly atrichs, 33.8–39.5 x 5–6.3 μ, partly basitrichs, 15.5–21.1 x 2.2–2.8 μ; those of the tentacles basitrichs, probably of two sorts, 15.5–33.8 x 2.2–3 μ; those of the actinopharynx partly basitrichs of two sizes, 19.7–25.4 x 3.5–4.6 μ, 15.5–28.2 x 2.2–2.8 μ, partly microbasic *p*-mastigophors, 18.3–19.7 x 5–5.6 μ; those of the filaments partly basitrichs, 21–36.7 x 4.2–5.6 μ and 15.5–28.2 x 2.5–2.8 μ, partly microbasic *p*-mastigophors, 18.3–22.6 x (4.2) 5.6–6.3 μ.

In the preserved state the largest specimen examined had a pedal disc (somewhat contracted) about 0.5 cm. in diameter, that of the column below the tentacles 0.7 cm. The length of the largest tentacles was about 0.8 cm.

Color: Brown with cream colored sectors on disc, a brown annulus around the mouth. Some samples are paler, with tentacles pale green at the tips (See also Hargitt and Field).

Distribution: Woods Hole, Massachusetts; Beaufort, North Carolina; Port Aransas, Texas.

Remarks: It has been pointed out to us by M. D. Burkenroad that there may be two anemones regularly inhabiting eupelagic *Sargassum*, a somewhat larger, darker form, fairly common in the Gulf of Mexico, but not in the Atlantic, and a smaller, light-colored form common in both Atlantic and Gulf. It is therefore not entirely certain whether the anemone described by Hargitt is the same as the *Actinia pelagica* of Quoy and Gaimard (*Voyage de l'Astrolabe*, Zool., vol. 4, p. 146, pl. 11, fig. 10). Milne Edwards and Haime (1857), vol. 1, p. 235), cited *pelagica* as a species of *Anemonia*, and it is not clear why their color description, based apparently on Quoy and Gaimard, was thought by Hargitt to be inapplicable to his specimens. Certainly Hargitt's belief that "compared with *A. sargassensis* [*A. pelagica*] has many points of difference, such as color, number of tentacles, etc." seems a poor basis for discarding Quoy and Gaimard's name. Hargitt's color figure, incidentally, appears to be out of scale as related to the sprig of sargassum, i.e., it is about twice as large as the dimensions indicated in the text. The color shown corresponds to that of the small, pale form, which may not reach the dimensions given in Hargitt's text. Adequate descriptions or determinations of anemones from mid-Atlantic *Sargassum* are not available in the literature; Timmermann (1932), for example, simply refers to "actinians," and in most accounts of the sargassum fauna they are not mentioned at all. If there is a single, variable species of anemone regularly inhabiting eupelagic *Sargassum*, there would be little doubt that Hargitt's species is a synonym of *A. pelagica* (Quoy and Gaimard). If there are two such species in the Gulf, the question whether Hargitt's name might refer to a different one than Quoy and Gaimard's remains open. Our description and illustrations apply to the larger, dark form, and probably to the species examined by Field at Beaufort.

Anthopleura krebsi Duch. et Mich.

Plate I; Figure 4, A–D.

Anthopleura krebsi Duchassaing and Michelotti, 1860, p. 49, Pl. VII, fig. 3; 1866, p. 126; Andres, 1883, p. 440; Whitten, Rosene and Hedgpeth, 1950, p. 74.
Bunodes krebsi Duerden, 1898, p. 454.

Material examined: North jetty, Brazos Santiago Pass, Texas; on small rocks at base of jetty, low tide, May 5, 1946; 2 specimens. J. W. Hedgpeth, coll.

Both specimens are young, and a detailed description cannot be given. The base is well developed. The column is provided with vertical rows of simple warts on its entire length, very indistinct on the preserved, extended specimens, but conspicuous in the living animal. The largest verrucae occur on the upper part of the column. Marginal spherules are present. The tentacles are few in these specimens. The sphincter is circumscribed, weak, probably because of the small size of the specimens (Fig. 4, B). As the species has been observed to divide by longitudinal fission (J. W. H.), the arrangement of the mesenteries is probably irregular. The retractors of the older mesenteries are rather well developed and more or less restricted; the parietobasilar

muscles form a distinct fold on the mesenteries. The specimens are not fertile. The nematocysts of the column are partly basitrichs, 17–19.7 x 2.5–2.8 μ, partly atrichs (probably; they are opaque), 16.5–19.7 x 4.2–4.5 μ; those of the marginal spherules partly atrichs, 32.4–43.7 x 4.5–5 μ, partly basitrichs, 12.7–15.5 x 2.2–2.8 μ; those of

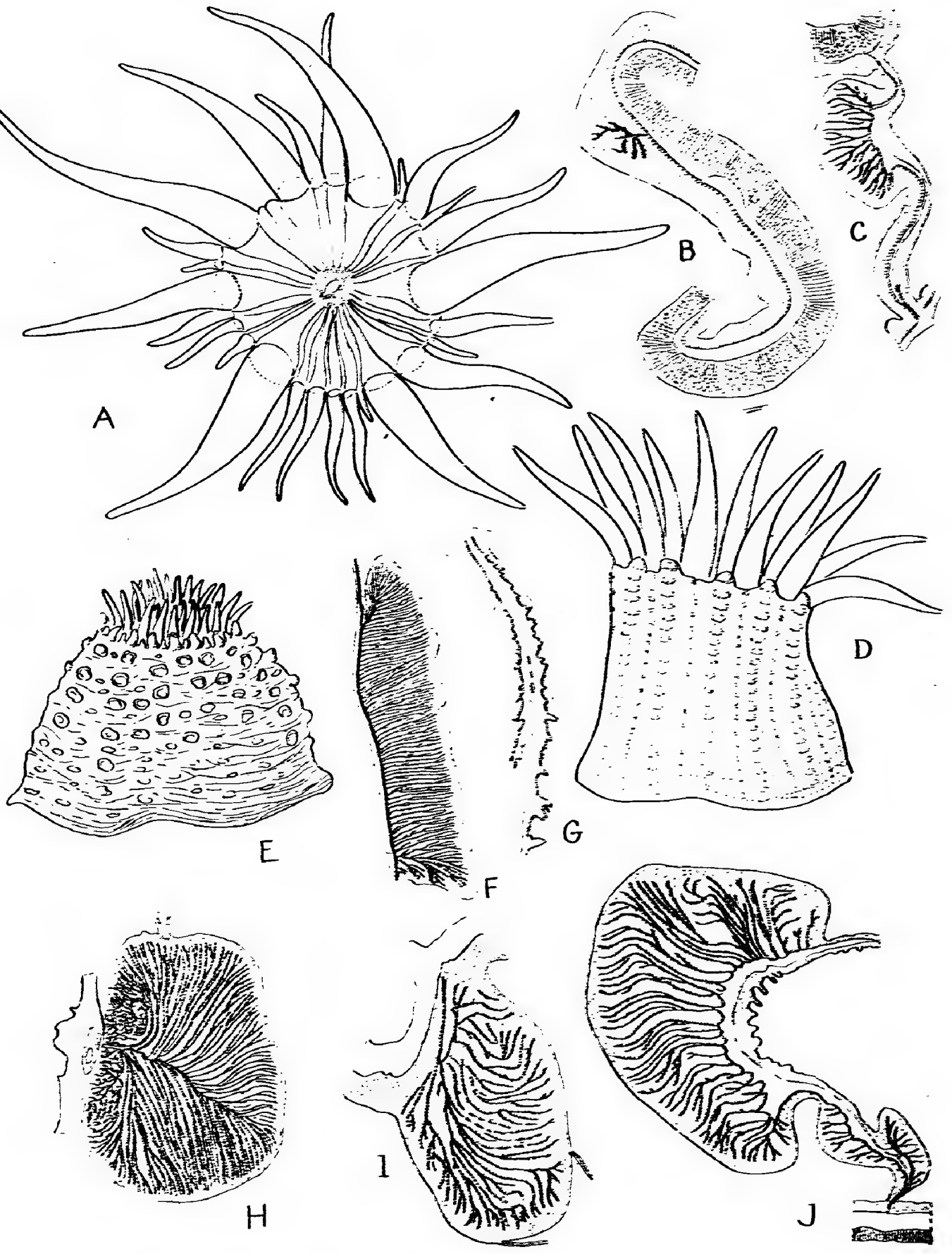

FIGURE 4

A–D: *Anthopleura krebsi* (Duch. et Mich.); A, oral view; B, sphincter; C, perfect mesentery; D, side view, E–H: *Bunodactis texaensis* n. sp.; E, view of partly contracted specimen; F, parieto-basilar muscle; G, retractor; H, sphincter. I–J: *Bunodactis* sp.: I, sphincter; J, section of perfect mesentery below the actinopharynx.

the tentacles basitrichs (very numerous), 15.5–18.3 x 1.5–2.5 μ; those of the actinopharynx partly basitrichs, 21–25.4 x 3–3.5 μ, partly microbasic *p*-mastigophors, 19.7–21 x ca. 5 μ; those of the filaments basitrichs, partly 18.3–28.2 x 4.2–5.6 μ, partly microbasic *p*-mastigophors, 17–19.7 x 5–5.6 μ.

The largest specimen is about 1 cm. long by 0.5 cm. broad. According to Duerden the length is 2.5 cm., the disc 2.3 cm. and the inner tentacles 1.2 cm. long. Evidently the species is always small.

Color: Column pale pink with light red warts in regular rows, tentacles white or transparent grayish lavender (See also Duchassaing and Michelotti, and Duerden).

Distribution: St. Thomas, Jamaica, south Texas.

Bunodactis texaensis, n. sp.

Plate I; Figure 4, E–H.

Material examined: Galveston, April 24, 1939. O. Sanders, coll. 1 specimen (Holotype, U.S.N.M. No. 49988); near Bell Buoy, Port Aransas, Texas, 10 fathoms, mud, Oct. 22, 1946, J. W. Hedgpeth, coll. 1 specimen.

Description: The pedal disc is broad. The whole column is provided with simple verrucae, larger in the upper part than in the lower. At the margin there is a ring of pseudospherules. The sphincter is strong, circumscribed with a thin, sometimes rather indistinct main lamella (Fig. 4, H). The tentacles are rather short, about 96, and hexamerously arranged. Their longitudinal muscles are ectodermal and palisade-like in arrangement. There are two siphonoglyphs, symmetrically set. The pairs of mesenteries are about 48, with two pairs of directives and 24 perfect mesenteries. The retractors of the 24 stronger pairs are band like (Fig. 4, G), the parietobasilar muscles are strong, forming a distinct fold on the mesenteries (Fig. 4, F). All the stronger mesenteries are fertile, including the directives. There are the same number of mesenteries at the margin as the base in the specimen from Port Aransas. The nematocysts of the column are basitrichs, 8.5–15.5 x 1.5–2 μ (12.7–17 x 2.2–2.5 μ); of the pseudospherules basitrichs, 10–12.7 x 1.5–2 μ (11.3–14 x 1.5 μ); those of the tentacles basitrichs, 17–21 x 2.5–2.8 μ (12.7–18.3 x 2.2–2.5 μ); of the actinopharynx partly basitrichs, 19–25.4 x 3 μ (21–26 x 3–3.5 μ), partly microbasic *p*-mastigophors, 17–19.7 x ca. 4.2 μ (16.2–18.3 x 4.2–5.6 μ), partly basitrichs, 22.6–38.4 x 3.5–5.6 μ (32.4–39.5 x 4.2–5.6 μ). The sizes in parentheses are of the nematocysts from the Galveston specimen, the other measurements are from the Port Aransas specimen.

The strongly contracted specimen is about 2.8 cm. in length and diameter; the other specimen is smaller.

Color: (Of the Port Aransas specimen) Column a uniform, translucent gray, tentacles gray with darker gray streaks, and pale to white annular patches on the first three cycles. Oral disc a pale brownish green with dark gray splotches and regular markings as indicated (Plate I). In formalin there is a greenish longitudinal band on each side of the tentacles.

Remarks: The decription above is based principally on the specimen from Galveston, because the specimen from Port Aransas has now been mislaid (O. C.); there is however no doubt that both are the same species.

Bunodactis? sp.

Figure 4, I–J.

Material examined: Bell Buoy, Port Aransas, Texas, Oct. 22, 1946, 1 specimen. J. W. Hedgpeth coll.; Jetty, Brazos Santiago Pass, March 20, 1947, 1 specimen. J. W. Hedgpeth coll.

These two immature specimens, collected from different localities are apparently identical species, and possibly are young *Bunodactus texaensis* (the sizes of the nematocysts agree rather well), or young *Anthopleura.* The young stages are very difficult to separate in these two genera. These genera are principally separated on the basis of the presence of marginal spherules (containing atrichs) in *Anthopleura* and their absence in *Bunodactis,* but in young *Anthopleura,* the marginal spherules are not developed. Therefore there is the possibility that these two specimens may be Anthopleuras. The column is cylindrical, provided with longitudinal rows of verrucae, which in the younger specimens from Santiago Pass are few, and present only in about the upper half of the body, and in the specimen from Port Aransas are indistinct on the lower part of the column. At the margin there is a ring of pseudospherules. In the larger specimen a rather well developed circumscribed sphincter is present (Fig. 4, I), in the smaller one it is apparently absent. It is, however, not impossible that the latter could have developed a circumscribed sphincter, as we know that the sphincter can be very weak in larger specimens than this one (Cf. *Bunodactis krebsi* and *Minyas (Stichophora) torpedo* (Haddon 1898)). Furthermore, too little is known about the time of development of the sphincter in a species. The tentacles are few in the smaller specimen, 44 in the larger one. There are two distinct siphonoglyphs and two pairs of directives. Twelve pairs of mesenteries, among them 6 pairs of primaries and at least a part of the second cycle, are perfect. The retractors are strong and band like, in the directives more restricted and kidney-like, or more restricted (Fig. 4, J). The parietobasilar muscle is strong and forms a distinct fold on the mesenteries (Fig. 4, J). Both specimens are sterile. The nematocysts of the lower part of the column are partly basitrichs, 12.7–15 x 2.5 (11.5–17 x 1.5–2 μ), partly opaque, indeterminable, 14–15.5 x 3–3.5 μ; of the marginal pseudospherules, very numerous basitrichs, 10.6–13.4 x 2.2 μ (10–14 x 1.5 μ); of the tentacles, basitrichs, 17–21 x 2.5 μ (14–21 x 1.5–2 μ); of the actinopharynx partly basitrichs, 18.3–24 x 2.8–3.5 μ (19.7–22.6 x 2.5–2.8 μ), partly microbasic *p*-mastigophors, 17–18.3 x 4.2 μ; of the filaments partly basitrichs, 22.6–33.8 x 3.5–6 μ (24–32.4 x 4.2– 5.6 μ), and 10–55.5 x 1.5–2 μ (10–14 x 1.5 μ), and microbasic *p*-mastigophors, 16.2–19 x 4.2 μ (17–19 x 4.5–5 μ). The nematocysts in parentheses are from the smaller specimen.

Size in preserved condition, of the Port Aransas specimen: length 1.5 cm., diameter, ca 0.9 cm. Of the specimen from Brazos Santiago: length, 0.7 cm. (in life, 1.2 cm.); diameter 0.2 cm., length of the tentacles about 0.3 cm.

Color: (Brazos Santiago specimen) Transparent, colorless.

Family MINYADIDAE

Minyas olivacea (Lesueur)

Figure 5, A–C.

Minyas olivacea Andres, 1833 (synonyms and literature), p. 556; Carlgren, 1894; Carlgren 1924, p. 66.

Material examined: "Front Beach," Grand Isle, Louisiana. E. H. Behre, leg. 1 specimen (of two collected).

Description: The body is melon-shaped with 20 longitudinal furrows indicating 20 pairs of mesenteries. Papillae as figured by Lesueur were not seen by Carlgren, but as they seem very small in the type, they may have disappeared in the young and preserved specimen. In the other, slightly larger specimen, there is a suggestion of such structures (J. W. H.). At the aboral end there is an opening to a cavity containing the proteinaceous(?) structure which functions as a float, as in other Minyadidae. The sphincter is endodermal, circumscribed, but very weak and sometimes more or less disappearing (Fig. 5, B). At least some tentacles are radially arranged, but the tentacle area is short in comparison with that described in an earlier paper (Carlgren 1924, p. 66); the arrangement of the mesenteries was cleared up in 1894. I have not seen that the outer tentacles have the appearance which Lesueur had indicated, and it is questionable that these tentacles were correctly figured, although they may have been somewhat branched. This is concluded from an examination of the largest specimen (length and breadth about 2.3 cm.) which was mentioned in 1894. In this specimen the outermost tentacles, which are larger than the others, are somewhat papillous. In general, new tentacles arise towards the mouth with the age of the animals, and doubling of tentacles often occurs in the rows inside the outermost tentacles. The single specimen sent from Grand Isle has not been dissected, as it cannot be expected to provide more information about the arrangement of the mesenteries than already available. A retractor is represented in figure 5, C. The nematocysts of the column are basitrichs. 14–18.3 x ca. 2.2 μ; of the tentacles basitrichs, 16.2–28.2 x 2.2–2.8 μ; of the filaments partly microbasic *p*-mastigophors, 17–21 x 4.2–5 μ, partly basitrichs, 19.7–22.6 x 3–3.5 μ.

The size of the preserved specimen is 1.2 cm., both length and diameter.

Color: In the preserved condition, dull muddy brown. According to Lesueur, yellowish in life.

Distribution: "The Antilles," Louisiana coast.

Remarks: It is very difficult to distinguish the species of *Minyas* from each other; probably there are actually only a few species. The present specimens have been referred to *olivacea* as the species is known from the Antilles. The specimen examined is certainly much younger than the type, but it is certain that the minyads are stichodactylin, and have a more or less developed circumscribed sphincter. Haddon's (1898) description of *Stichophora torpedo* seems to contradict this supposition but his specimen was certainly a very young one, as confirmed by the appearance of the sphincter, which consists only of a single fold, indicating, however, that it may later be developed into a circumscribed one (compare the weak sphincter in our specimens). Therefore I think the diagnosis of the family proposed in Carlgren (1949, p. 71) is correct.

Added note on Minyas olivacea: A living specimen was found on the beach at Port Aransas, Texas, by Martin D. Burkenroad, to whom we are indebted for the following observations. The individual was 6 cm. by 1.5 cm. when expanded; in the contracted state it was about 1.5 cm. in all directions. The color was olivaceous brown with paler stripings. The animal could retract its tentacles completely, and the float does not appear to be an integral part of the animal, but rested like a cap on the pedal disc. When subjected to menthol the animal shed the float and attached itself to the glass of the

aquarium when pressed against it. [Unfortunately there is no fertile ***Minyas*** known, but if these observations are correct it is possible that ***Minyas*** when full grown has a pedal disc capable of attachment, but it is undoubtedly a distinct genus.]

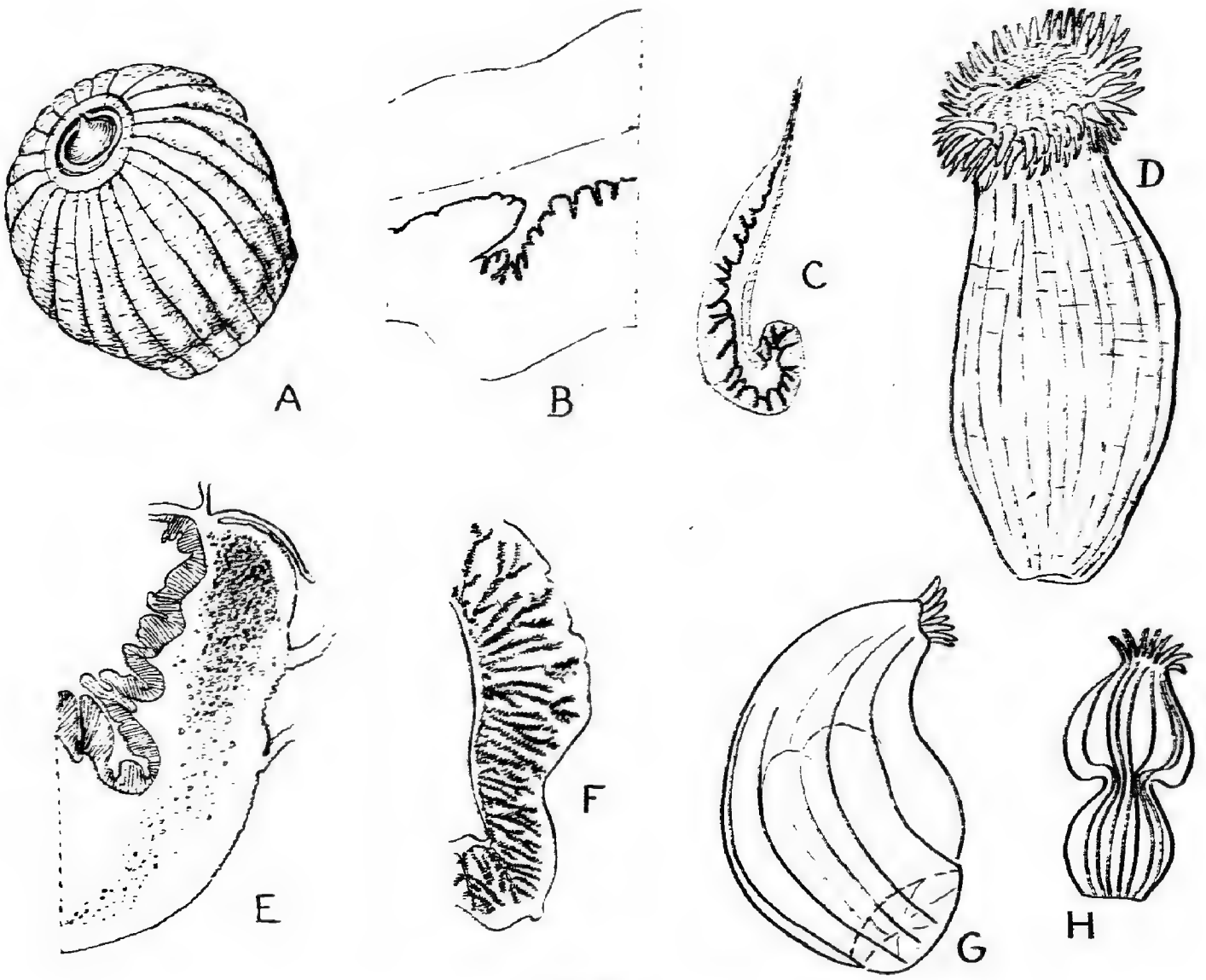

FIGURE 5

A–C: *Minyas olivacea* (Lesueur): A, view of aboral end, showing float enclosed in base; B, sphincter; C, mesentery. D–H: *Paranthus rapiformis* (Verrill); D, sketch of living specimen; E, sphincter: F, mesentery; G, H, sketches of living individual. (E, F, after Carlgren, 1934).

Family ACTINOSTOLIDAE

Paranthus rapiformis (Lesueur)

Plate II; Figure 5, D–H.

Actinia rapiformis Lesueur, 1817, p. 171.

Ammophilactis rapiformis Verrill, 1899, p. 213, figs. 28, 33 (literature).

Paranthus rapiformis Carlgren, 1934, p. 19, figs. 11, 12.

Paractis rapiformis Field, 1949, p. 15, Pl. II, figs. 19, 23–28, Pl. IV, fig. 37.

Material examined: Port Aransas, Texas, 10 fathoms, mud bottom, Jan. 11. 1946, J. W. Hedgpeth, 1 specimen; Port Isabel, ship channel, sandy bottom, March 15, 1947, 2 specimens. J. W. Hedgpeth.

Description: The anatomy of this species is described by Verrill, (1899) and Field (1949), and especially by Carlgren (1934). Field notes that there was no sphincter

and no filaments in the specimens she examined. As we know that the filaments occur early in the development of the Actiniaria they must certainly have been present in her specimens, and possibly the mesogleal sphincter was also overlooked. Field did not find more than six perfect pairs of mesenteries; probably she did not examine the mesenteries of the oral disc; in a young specimen there are six pairs and two unpaired mesenteries perfect in the lower part of the actinopharynx. The nematocysts of two specimens, one large, and one small and sterile, have been examined. Those of the smaller specimen are enclosed in parentheses: The nematocysts of the column are partly basitrichs, 12.7–14 x 1.5–2 μ (11.3–12.7 x 2.8 μ), partly probably microbasic *p*-mastigophors, 14.1–22.6 x 2.8–5.6 μ (12.7–17 x 2.8–3.5 μ); those of the tentacles partly basitrichs, 18.3–25.4 x 2.5 μ (19–22.6 x 2.5–3 μ), partly common microbasic *p*-mastigophors (probably), 22.6–27.5 x 4.2–4.5 μ (22.6–25.4 x 4.2–4.5 μ); those of the actinopharynx partly basitrichs, 21.1–25.4 x 2.5–3 μ (18.3–21.1 x 2.5 μ), partly *p*-mastigophors or amastigophors, 19.7–24 x (4.2) 5.6–7 μ (19.7–22.6 x 3.5–4.2μ); those of the filaments partly basitrichs, 12.7–14 x 2.2 μ (10.5–14 x 2.2–2.5 μ), partly microbasic *p*-mastigophors, 10–14.8 x 4.2 (5.6) μ (8.5–10.6 (14) x 4.2–5 μ), partly amastigophors (?), 18.3–32.4 x 6.3–7 μ (15.5–26.8 x 4.2–7 μ).

Size of the largest specimen (preserved), 2.3 cm. long by 1.5 cm. in diameter.

Color: Column grayish white or cream, tentacles gray green with warker greener base, oral disc green, with pale salmon markings, transparent between (Port Aransas). In a young specimen from Port Isabel the column was transparent, from colorless to white, oral disc almost colorless with gray splotches and orange mesentery lines (See also Verrill and Field). When brought on deck by the trawlers, these anemones contract to a nearly spherical shape and resemble peeled onions, and are sometimes known as "sea onions" by the fishermen.

Distribution: New Haven, Connecticut; Egg Harbor, New Jersey; Beaufort, North Carolina; Grand Isle, Louisiana. Common in shallow water along the Texas coast.

Remarks: Field states that "the original description of the genus *Paranthus*, Carlgren, 1934, is unobtainable." It is true that the type of *Paranthus (P. cromatoderus)* was not described in the 1934 paper, but it and *P. rapiformis* have been examined (Carlgren 1898, p. 27, also 1949, p. 82), and the genus dates from Andres (1883). The sphincter is rather strong in the sample from Port Aransas. Unfortunately the character of the sphincter in the young specimens from Port Isabel cannot be determined. No distinct sphincter could be made out in the smaller specimen, and the upper part of the second sample was lost during manipulation. However, the sample from Port Isabel is probably *rapiformis* (see below).

Paranthus rapiformis?

Material examined: Barataria Bay, Louisiana. Nov. 2, 1946. E. H. Behre coll. 2 small specimens.

The two very small specimens from Louisiana are very difficult to determine. The types of the nematocysts, especially in the filaments, agree rather well with those occurring in the Actiniaria having two types of nematocysts in the acontia as well as with those present in *Paranthus*,[5] but because no acontia are present (and

[5]It is probable that *Paranthus* must be separated from all the other Hormathiidae and assigned to a new family, Parantheidae, since the nematocysts seem to agree with the forms having two types of nematocysts in the acontia, but the types of nematocysts must be cleared up in living specimens of *Paranthus* before such a new family can be erected. (O.C.)

the acontia seem to develop early, in some forms as early as the larval stage), it is hardly probable that these specimens represent a species with acontia. Probably the specimens can be referred to *Paranthus,* and possibly to *rapiformis,* as the nematocysts agree rather well with those of this species (see below), although no sphincter is developed and the number of tentacles and mesenteries is the same. It is not known at which time the mesogleal sphincter arises in *Paranthus,* or when the mesenteries increase in number in the distal end as against the proximal part of the animal. Probably this differentiation takes place late in *Paranthus.* Nevertheless, a description of these two small specimens is given in the following paragraph.

The body in the preserved condition is cylindrical, the column smooth. There is apparently no sphincter present. The tentacles are rather short, conical and 44 in number in the larger specimen. There are two siphonoglyphs, symmetrically placed. There are six pairs of perfect mesenteries and two cycles of imperfect mesenteries, in all 44 mesenteries at the base. Thus there are apparently the same number of mesenteries at the margin as at the base. Only the first cycle of mesenteries bear filaments. The retractors are present only on the mesenteries of the first cycle, and are diffuse or somewhat restricted. The parietobasilar muscles are weak. The specimens are sterile. In spite of a hard search, no acontia were found. The nematocysts of the column are partly basitrichs, 8.5–12 x 1.5–2 μ, partly probably microbasic *p*-mastigophors (common), 12.7–19.7 x 3.5–4.2 μ; those of the tentacles partly basitrichs (common), 12.7–15.5 x 2.2–2.5 μ, partly *p*-mastigophors or amastigophors, 19–21.8 x 4.5 μ; those of the actinopharynx probably amastigophors, 19.7–22.6 x ca. 4.2 μ; those of the filaments partly basitrichs, 8.5–11.3 x 1.5 μ, partly microbasic *p*-mastigophors, 6.3–12.7 x 4–4.5 μ and 17.6–21 x 4–4.5 μ, partly microbasic amastigophors (?), 26.8–29.6 x 5.6–6.3 μ.

The larger specimen is 0.45 cm. long, 0.2 cm. in diameter.

Color: Pale greenish gray, with darker green lines marking the mesenteries on the oral disc.

Family HORMATHIIDAE

Calliactis tricolor (Lesueur)

Plate II; Fig. 6, A.

Adamsia tricolor McMurrich 1898, p. 234, Pl. 1, figs. 6, 7, Pl. 2, figs. 1, 2.

Calliactis tricolor Haddon, 1898; p. 457; Watzl, 1922, p. 61, fig. 7; Pax, 1924, p. 106; Field, 1949, p. 12, Pl. V, figs. 47–52, Pl. VII, figs. 60, 61, Pl. X, fig. 94. For further literature and synonymy see Andres (1883) and Field (1949).

Material examined: Several specimens from near Port Aransas, Texas, usually on carapace of Calico crab, *Hepatus epheliticus,* 1 specimen on small chip in sand bottomed tide pool. J. W. Hedgpeth, coll.

Description: The anatomy of this species has been described by McMurrich (1898), Field (1949) and especially by Duerden (1902). There is nothing further to add other than the type and size of the nematocysts. The nematocysts of the column are basitrichs, 12–14 x ca. 2.2 μ; of the tentacles, basitrichs, 21–24 x 2.5–3 μ; of the actinopharynx basitrichs, 21–26.8 x 3 μ; of the filaments partly very numerous microbasic *p*-mastigophors, 19–24 x 4.2–5 μ, partly sparse basitrichs, 11.3–12.7 x ca. 1.5 μ; of the acontia basitrichs, 21–26.8 x ca. 3 μ.

Distribution: Beaufort, North Carolina, to Florida; Cuba, Puerto Rico, St. Vincent, Barbados, St. Thomas, Jamaica, Curaçao, Texas.

Color: Column somewhat glossy light brown with white ridges at the base (sometimes white vertical stripes on column) and bright brown cinclides, tentacles pale cream with brown or maroon bands, directive tentacles in one specimen orange. Oral disc pale cream, actinopharynx bright orange with pale magenta shading on disc. Acontia orange (See also Duerden, and Field).

Remarks: This is the most common anemone found along the Texas coast to about 10–15 fathoms; it occurs on the carapace of the calico crab, and on shells carried by the large red hermit crab, *Petrochirus bahamensis*. On the larger shells there may be four or five of these anemones. Off the south Atlantic coast the species has been taken from living shells of *Rehderia georgiana*.

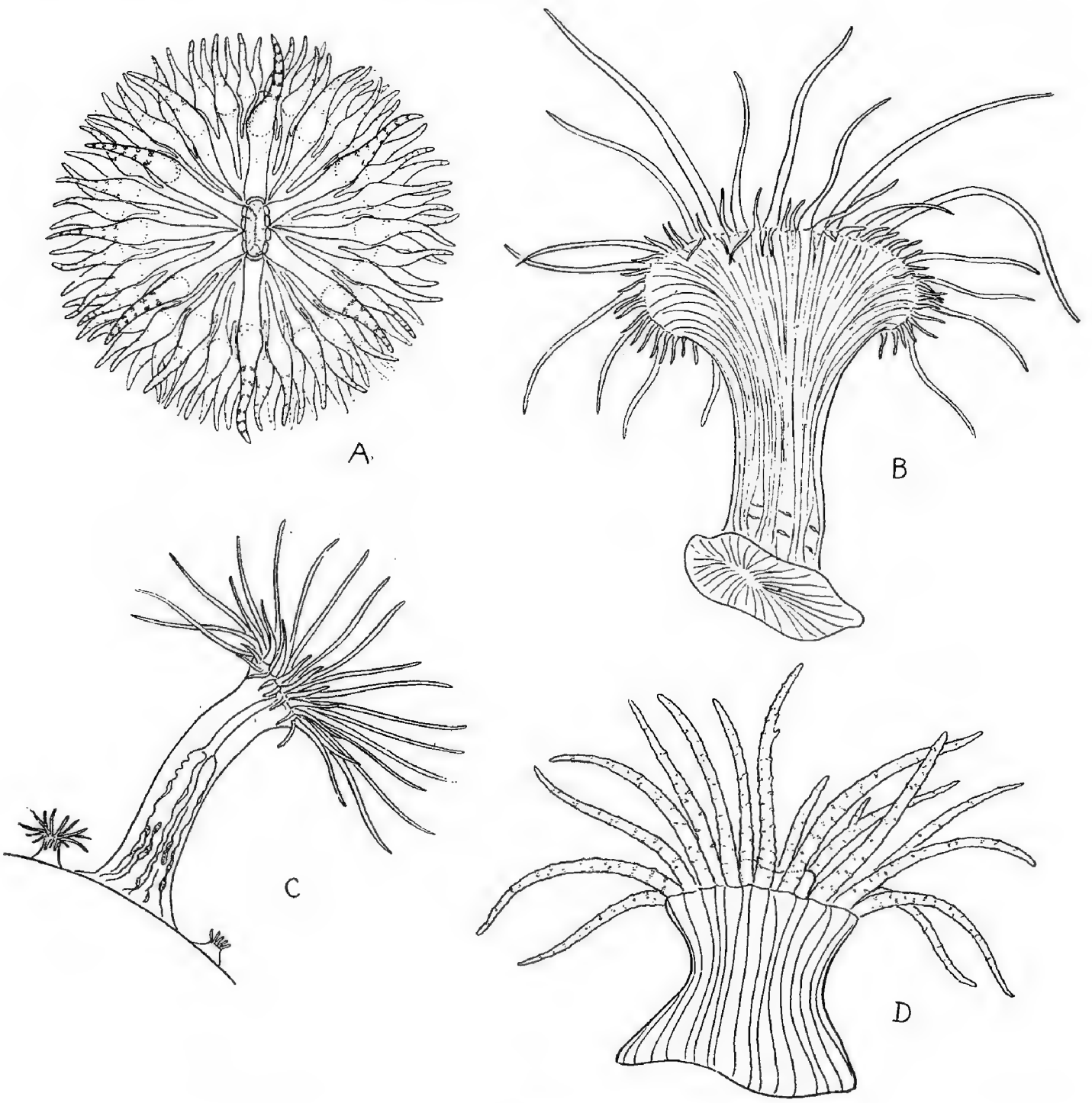

FIGURE 6

A: disc of *Calliactis tricolor* (Lesueur); B–C: sketches of *Aiptasia pallida* (Verrill); D, sketch of juvenile specimen of *Bartholomea annulata* (Lesueur).

In the association with *Hepatus epheliticus*, only one anemone has been observed on a crab. It is located on the middle of the carapace, near the anterior margin. When observed in a small aquarium, the respiratory currents set up by the crab move forward away from the front of the carapace, inducing a converging current from the rear to move forward over the disc of the anemone. It seems probable that when the crab is feeding the anemone may be able to trail its tentacles into the respiratory stream from the crab's mouth and thus pick up bits of food. A similar association between an anemone and a calappid crab occurs on the Chilean coast. In this case the anemone is the actinostolid *Antholoba achates* (Dana) and the crab is *Hepatus chiliensis* M.-E. According to Bürger (1903) there is usually but one anemone on a crab although there may rarely be two, and when separated from its crab in an aquarium, the anemone will eventually orient itself upside down and attach itself to the crab by its upended pedal disc and move to its former position on the middle of the carapace. Bürger was able to perform this experiment twice and concluded that it was the actinian that took the initiative in the association and was the active beneficiary in the association. It would not appear that the crab derives any advantage from this association although it may receive, fortuitously, some protection or concealment from the presence of the anemone on its back.

Family AIPTASIIDAE

Aiptasia pallida (Verrill)

Plate III; Figure 6, B–C.

Dysactis pallida Verrill, 1864, p. 26.

Paranthea pallida Verrill, 1868, p. 322.

Aiptasia agassizii Andres, 1883, p. 391.

Aiptasia sp. McMurrich, 1887, p. 59.

Aiptasia pallida Parker, 1900, p. 755; Carlgren, 1949, p. 107.

Cylista leucolena Field, 1949, p. 13 (in part; also by designation as footnote to table on p. 6!).

Material examined: South Bay, Port Isabel, Texas, on oysters May 15, 1946 (No. 8); North Jetty, Brazos Santiago Pass (Port Isabel), on rocks with *Anthopleura krebsi*, March 20, 1947 (No. 15); Off Port Isabel, 12 fathoms, on old valves of *Atrina* April 2, 1947, small colonies (No. 17). J. W. Hedgpeth, coll.

Description: The pedal disc is rather well developed but of smaller diameter than the oral disc. The body is more or less pillar-like with cinclides arranged in one or two circles about in the middle of the column. In the contracted state the column forms a parapet above the cinclides as in many other species of *Aiptasia*, dividing the column indistinctly into scapus and capitulum. The margin is tentaculate. The sphincter is rather long, consisting mostly of a single row of meshes situated in the middle of the mesoglea. The tentacles are smooth, not retracted, up to about 97 in number, the inner long, the outer shorter. There are two siphonoglyphs and two pairs of directives. Three examined specimens had six pairs of perfect mesenteries. In a sectioned, small specimen from 12 fathoms the lateral perfect mesenteries were considerably weaker

than their partners, indicating that the individual had arisen by laceration (constriction). The retractors of the perfect mesenteries are strong, diffuse, the parietobasilar muscles weak. The nematocysts of the column are partly basitrichs (common), 14–18.3 x 2.5 μ (11.3–19.7 x 2.2–3 μ, 10–14 x 2.2–2.5 μ); partly microbasic *p*-mastigophors, 18.3–24 x 4.2–5 μ (17–22.6 (25.4) x 4.2–5.6 μ; 17–19.7 x 4.5–5 μ); those of the tentacles partly basitrichs, 14.8–19.7 x 2.8 μ (14–18.3 x 2.2–2.5 μ; 12.7–17 x 2.2–2.5 μ); partly microbasic *p*-mastigophors 24.7–34.5 x 4.2–5 μ (24–29.6 x 3.5–4.2 μ; 26.8–32.4 x 4.2–5.6 μ); those of the actinopharynx partly basitrichs, 9.2–17.6 x 1.5–2.8 μ (———; 10–14 x 2.2–2.5 μ); partly microbasic amastigophors, 22.6–31 x 4.2–5 μ (19.7–24 x 3–3.5 μ; 17–22.6 x 3.5–4.2 μ); those of the filaments partly basitrichs (few), ca. 17 x 2.8 (14–15.5 x 2.5 μ; 10–14 x 2.8 μ); partly microbasic *p*-mastigophors, 10–17 x 3.5–4.5 μ (11.3–15.5 x 3 μ; 10–18.3 x 4.2–4.5 μ), and 29.6–36.7 x 5.6–7 μ (32.4–36.7 x 4.5–5.6 μ; 29.6–39.5 x 5.5–5.6 μ); those of the acontia partly microbasic *p*-mastigophors, 60.6–75.4 x 7–8.5 μ (48–66.7 x 5.5–7 μ, 58–67.7 x 6.3–7.7 μ), partly basitrichs, 22.6–26.8 x 2–3 μ (29.6–35.3 x 2.2–2.5 μ, 17–19.7 x 2.2–2.5μ). The nematocysts of three specimens were measured, the first from lot No. 8, the other two (in parentheses) from No. 15, and a small specimen from No. 17.

The largest specimen (from lot No. 8) measured 1.5 cm. in length, the diameter of the oral disc about 1.3 cm., of the pedal disc 0.8 cm.

Color: Column brown, striped with darker brown, tentacles deep reddish brown to pale chocolate, oral disc various combinations of brown and cream or brown-cream white, acontia white (Lot No. 8—see Plate III). Tentacles gray-cream, oral disc pale red-brown (No. 15). Column transparent, revealing the pale yellow brown viscera, tentacles powder blue, fading toward the transparent disc (No. 17).

Distribution: North and South Carolina. Cameron, Louisiana jetty (Cary, 1906). Although very abundant on oysters in South Bay near Port Isabel, and occurring sparsely on the nearby jetties, this anemone was not collected in Aransas Bay or from the Port Aransas area during the years 1945–1949. The powder blue phase has been collected only offshore in the Port Isabel region on the Texas coast.

Remarks: In the ectoderm of the tentacles in a specimen from Lot No. 8 there are numerous round or oval bodies, probably gregarines.

In 1947 a dozen or so of these anemones were transported to Rockport and maintained in battery jars for several weeks. Within a short time very small individuals appeared on the walls of the jars. The animals withstood the concentration of sea water resulting from as much as an inch and a half to two inches evaporation, and when the original level was restored by the addition of distilled water, showed no ill effects. Attempts to acclimate them to local Aransas Bay water were, however, unsuccessful. The addition of bay water to a jar whose level had dropped an inch caused all the anemones in that jar to die within a few hours. The anemones are cannibalistic—if the term may thus be broadly used—eating not only their own species, but other anemones as well. A specimen of *Bunodosoma cavernata*, dropped into a jar, passed too near the expanded disc of an *Aiptasia* and was almost instantaneously engulfed in a spasmodic motion. It should be noted that this habit may lead to nematocyst contamination, especially if a number of different live anemones are placed in the same collecting receptacle.

Bartholomea annulata (Lesueur)

Figure 6, D.

Actinia annulata Lesueur, 1817, p. 172.

Aiptasia annulata McMurrich, 1889, p. 7, Pl. 1, fig. 1; Duerden, 1902, p. 355, Pls. III, XI, XII, figs. 11, 41–44; Pax, 1910, p. 206; Weill, 1934, p. 578, figs. 60, 131, 386, 388, 389.

Bartholomea annulata Stephenson, 1920, p. 532; Watzl, 1922, Pax, 1924, p. 107, fig. 12; Carlgren, 1949, p. 108.

Material examined: From sargassum, St. Joseph Id., Texas, April 8 1946; several specimens. J. W. Hedgpeth, coll.

Description: The specimens taken from sargassum are all very young, but the tentacles have the typical appearance for *Bartholomea.* The species has been previously described by McMurrich and Duerden, especially the latter. The nematocysts of these specimens are considerably smaller than in the full grown individuals. The microbasic *p*-mastigophors of the tentacles are 26–32.4 x 3.5–4.2 (5) μ, the basitrichs 8.5–12.7 x ca. 2 μ; the microbasic *p*-mastigophors of the filaments are partly 21–28 x 4.2 μ, partly 4.2–8.5 x 2.8 μ, oviform, the basitrichs 7.7–10 x 2 μ.

Color: Transparent white, or faint brown with a thin blue border around the mouth.

Distribution: Bermuda and the Bahamas, Puerto Rico, Jamaica, St. Thomas, Guadeloupe, Barbados, Curaçao, Texas.

Family AIPTASIOMORPHIDAE

Aiptasiomorpha luciae (Verrill)

Plate IV; Figure 7, A.

Sagartia luciae Verrill, 1898, p. 493.

Diadumene luciae Stephenson, 1925, p. 888, fig. 1, F; Uchida, 1932; Stephenson, 1935, p. 197, figs. 75, 79 (literature); Carlgren, 1945, p. 19; Field 1949, p. 10.

Aiptasiomorpha luciae Carlgren, 1949, p. 109.

Material examined: Lydia Ann Channel, Port Aransas, Texas, March 1, 1948. 4 specimens. J. W. Hedgpeth, coll.

The specimens are small. The nematocysts of the tentacles and filaments agree very well in size with those found in a small individual from Busum (Carlgren, 1945, p. 19). The largest specimen (preserved), is 0.6 cm. high by 0.7 cm. largest diameter.

This species is not synonymous with *Diadumene cincta,* and in the survey paper (Carlgren, 1949) was referred to *Aiptasiomorpha,* but the definite name of the genus cannot be decided until the type of the genus *Diadumene, D. schilleriana,* is examined. It is, however, very probable that *D. cincta* and *D. schilleriana* are not referable to the same genus.

Distribution: See Stephenson (1935) and Carlgren (1949); also the comments in the introduction to this paper.

Remarks: It would appear, from the wide range of salinities represented by the localities from which this species has been reported, that salinity is not the limiting factor in its distribution. This has been demonstrated experimentally by Miyawaki (1951), who found that specimens could survive in distilled water for two days, for 12 days in a mixture of 1/8 sea water and distilled water, and indefinitely in a 3/8 concentration of sea water. At the other end of the salinity spectrum, specimens lived in salinities of about 74°/oo for four days without previous acclimation. Such extremes are well outside the ranges in which this species is found in nature.

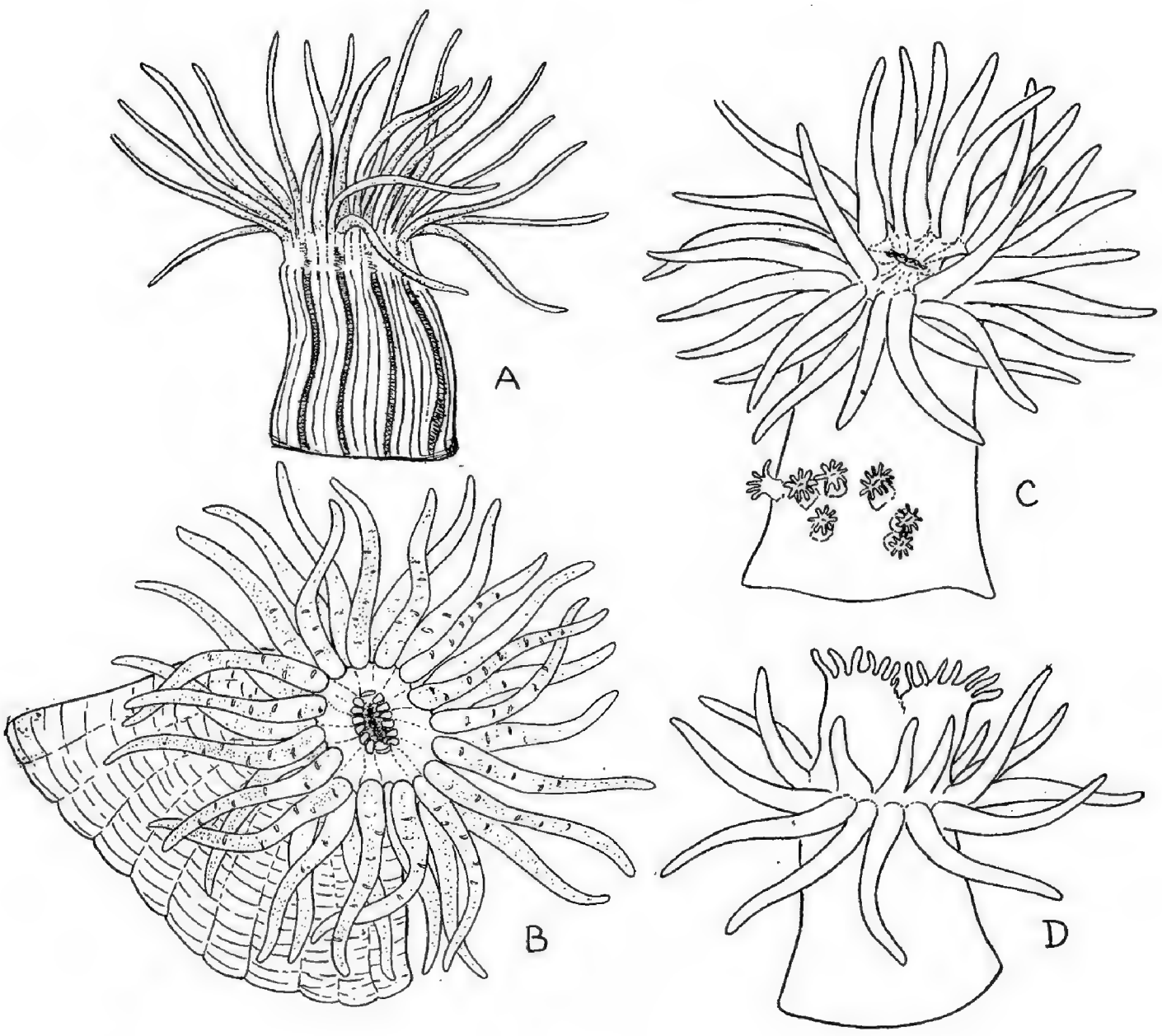

FIGURE 7

A: *Aiptasiomorpha luciae* (Verrill); B–D: *A. texaensis,* n. sp.; various views, showing asexual reproduction; the base of B is about 3 mm wide.

Aiptasiomorpha texaensis n. sp.

Figure 7, B–D.

Material examined: Rockport, Texas, among bryozoan on piling (3 specimens) Nov. 13, 1945; Port Aransas, Texas, from shell of live oysters, 2 specimens; on oysters, Bay Chêne Fleuri, Louisiana, Sept. 9, 1947, 1 specimen. (All coll. by J. W. Hedgpeth), (Holotype, U.S.N.M. No. 49993, from oyster, Rockport, Texas, Nov. 13, 1945).

Description: The pedal disc is well developed; the column apparently divisible into scapus and capitulum. In the contracted state the capitulum is somewhat drawn into the scapus. A ring of cinclides is present, about in the middle of the column. A sphincter is apparently absent. In four specimens sectioned, no traces of a mesogleal sphincter were found, but the endodermal muscles of the column are fairly well developed. The tentacles are long, somewhat more than 30 in number, apparently not retractile, the inner tentacles at least half as long as the length of the column. There are two distinct siphonoglyphs, and six fertile pairs of mesenteries, among them two pairs of directives. The retractors of the perfect mesenteries are restricted, the imperfect mesenteries of the second order are considerably weaker than the perfect mesenteries, but some of

them at least are provided with filaments. The species probably reproduces by laceration, as young individuals have been observed on the column of one specimen (J.W.H.).

The nematocysts of the specimen from Louisiana, and of a specimen from Port Aransas and from Rockport (the latter two indicated in parentheses) have been examined. The nematocysts of the column are partly basitrichs, 11.3–15.5 x 2.2–2.8 μ (12–12.7 x 2.5 μ; 9.2–14 x 1.5–2.8 μ), partly *p*-mastigophors or amastigophors, 10.6–14.6 x 3.5–4.2 μ (11.3–15.5 x 3.4–4.2 μ; 12–18.3 x 4–5 μ); those of the tentacles partly basitrichs, 12.7–17.5 x 1.5–2 μ (13.4–15.5 x 1.5 μ; 12.7–15.5 x 2 μ), partly microbasic *p*-mastigophors or amastigophors, (17) 21–24 x 4.2 μ (19.7–21 x 3.5–4 μ; 18.3–22 x 3.5–4 μ); those of the actinopharynx partly microbasic *p*-mastigophors or amastigophors, 17–21 x 3.5 (17–22.6 x 3.5–4 μ; 19–21.8 x 3.5–4.2 μ) partly a few basitrichs, 15.5–17 x 1.5–2.2 μ (12.7–14.1 x 1.5 μ; 12.7–15.5 x 1.5–7.5 μ); those of the filaments partly microbasic *p*-mastigophors, 6.3–12.7 x 3.5–4.2 μ (6.3–13 x 3.1–4.2 μ; 7.7–19.7 x 3.5–4.2 μ), partly microbasic *p*-mastigophors or amastigophors. 18.3–22.6 x 3.5–4 μ (17–21 x 3.5–4 μ; 15.5–21 x 3–3.5 μ), partly, a few basitrichs, possibly, from the acontia, 14–15.5 x 1.5 μ (10–12.7 x 1.5 μ; 11.3–12.7 x 1.5 μ); those of the acontia partly basitrichs, 12.7–17 x 1–2 μ (15.5 x 1.5 μ; 11.3–12.7 x 1.5 μ), partly *p*-mastigophors or amastigophors, 28.2–31–7 x 5–7 μ (21.8–25.4 x 5.6–7 μ; 26.8–31.7 μ x 5.6–7 μ). It has been impossible to determine, from the available material, whether the larger nematocysts of the acontia are mastigophors or amastigophors.

The animals are 0.5–0.6 cm. in diameter.

Color: Very pale orange cream or salmon pink, with gray center in the tentacles.

Remarks: The specimens were not well preserved, but as there is apparently no sphincter, they cannot at present be referred to *Aiptasia,* which they resemble. Possibly the absence of a sphincter is associated with the small size of the specimens, but as the primary mesenteries are fertile and specimens of *Aiptasia* of about the same size or a little larger show a distinct mesogleal sphincter, it seems hardly probable that this species should develop a mesogleal sphincter in a more advanced stage. Although it cannot be decided whether there are microbasic *p*-mastigophors or amastigophors in the acontia, it is suggested nevertheless that they are *p*-mastigophors (O.C.). As no sphincter is present, the species may at present be referred to *Aiptosiomorpha.*

A few of these small anemones were also collected in Copano Bay. There occurrence here and in Louisiana waters indicates that this species is a form tolerating salinities as low as 9–10 0/00. It was not observed at Port Isabel, where the salinities in South Bay are usually above 30 0/00 and and the record from Port Aransas is from oysters in experimental trays moved from Copano or Aransas bays a short time before.

Family SAGARTIIDAE?

Genus **Botryon** n. gen.

Column provided with tubercles (thickenings of the mesoglea), more or less regularly arranged in longitudinal rows. Sphincter mesogleal. Tentacles short, not very numerous. Two distinct siphonoglyphs and two pairs of directives. Twelve pairs of mesenteries perfect. All, or almost all, mesenteries fertile. The male sexual organs grape-like. Retractors of the perfect mesenteries well developed, parietobasilar muscles weak. Acontia present, their nematocysts basitrichs and probably microbasic amasti-

gophors (until the latter are decided with certainty the systematic position of this genus cannot be decided).

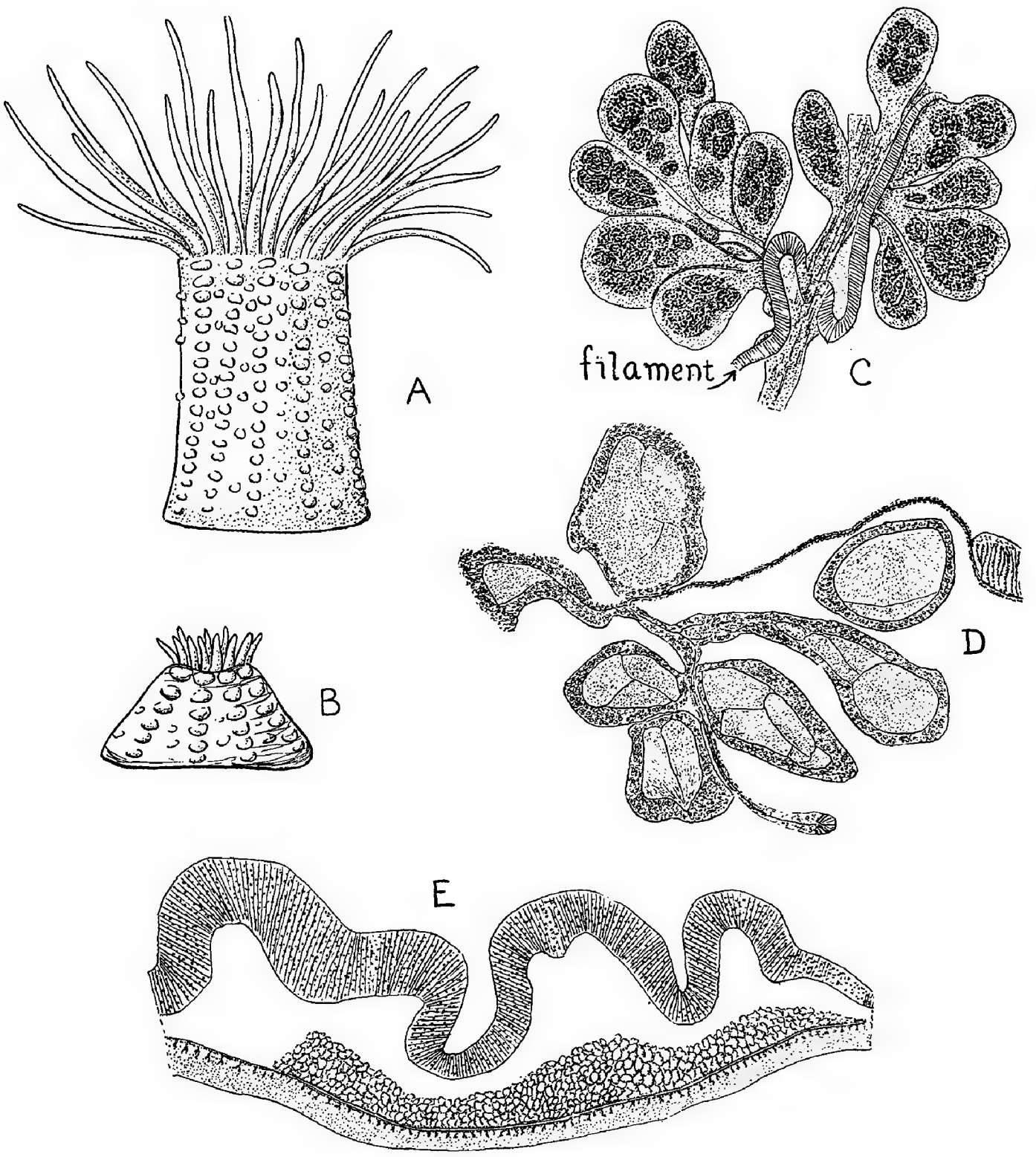

FIGURE 8

Botryon tuberculatus, n. gen., n. sp.; A, B, sketches of living specimen; C, part of a mesentery showing the botryoidal clusters and the filament; D, section of a mesentery showing male organs and a part of a retractor; E, sphincter.

Botryon tuberculatus n. sp.

Plate IV, Figure 8, A–E.

Material examined: Ship Channel, Port Isabel, March 27, 1947. 1 specimen, sandy bottom. J. W. Hedgpeth, coll. (Holotype, U. S. N. M. No. 49999.)

Description: The body in expanded state cylindrical, the pedal and oral discs of about the same diameter in the contracted states; the pedal disc is, however, somewhat

wider (Figure 8B). The column is provided with papillae, showing a distinct tendency to be arranged in longitudinal rows, distinctly visible on a sketch of the living specimen (Figure 8, A–B). The papillae are thickening of the mesoglea, but their ectoderm is more compact than the other ectoderm of the column. There are, however, no foreign bodies attached to the papillae in the single specimen. The sphincter is well developed, mesogleal, reticular, occupying about half of the thickness of the mesoglea and separated from the endodermal muscles of the column by a thin mesogleal lamella (Figure 8, E). The tentacles are short, conical, the inner longer than the outer and between 70–80 in number. The actinopharynx is longitudinally furrowed and there are two distinct siphonoglyphs. The perfect pairs of mesenteries are twelve in the uppermost part of the ectinopharynx, six in the lower part. All—or almost all—of the mesenteries are fertile. Of particular interest is the appearance of the male organs, which form *botryoidal clusters* (Figure 8, C), not previously observed in any actiniarian, but somewhat suggestive of the arrangement of the reproductive organs in the Ptychodactiaria. The retractors of the mesenteries are restricted (Figure 8D) and of about the same appearance as those in *Aiptasia;* the parietobasilar muscles are weak. The nematocysts of the column are partly basitrichs, 13.3–14 x 2.2–2.5 μ, partly (12.7) 14.8–17 x 3.5–4 μ, opaque *p*-mastigophors or amastigophors; those of the tentacles partly basitrichs (12.7) 14–15.5 x 2.2–2.5 μ, partly *p*-mastigophors or amastigophors, 15.5–19 x 3–3.5 μ; those of the actinopharynx partly numerous basitrichs, 19.7–24 x 2.5–2.8 μ, partly microbasic *p*-mastigophors, 15–19.7 x 3.5–4.5 (5) μ; those of the filaments partly numerous microbasic *p*-mastigophors, 10–12.7 x 4.2–5 μ, partly probably *p*-mastigophors, 18.3–21 x 3.5–4.2 μ; those of the acontia partly basitrichs, 21–26.2 x 2.8 μ; partly probably amastigophors, 26.8–32.4 x 4.2–5 μ (the shaft in the unexploded capsules is about 2/3–3/4 the length of the capsules).

Size, in the expanded, preserved state: Body, 1.2 cm. long, diameter of the base 0.45, at the margin 0.5. Length of the inner tentacles, 0.3 cm.

Color: Tentacles pale green cream, center of oral disc violet, the base of the tentacles of cycles 1–3 olive green, disc at the base of cycle 4 pale orange (Plate IV).

Order ZOANTHARIA

Family ZOANTHIDAE

Palythoa texaensis n. sp.

Figure 9, A–C.

Material examined: Port Isabel, Texas, 10–12 fathoms, on old shells. April 1, 1947. 3 specimens. J. W. Hedgpeth, coll. (Holotype, U. S. N. M. No. 49989.)

Description: Three small polyps, not connected by a coenenchyme. The column is very strongly incrusted with sand grains, occupying the whole mesoglea. There are 14 distinct scapular ridges. The ectoderm of the column is thin and discontinuous, its cuticle weak. The mesoglea is thick and provided with numerous cells and cell-islets, the latter situated near the endoderm, which is thinner than the ectoderm (Figure 9, C). The mesogleal sphincter forms a single row of large muscle meshes (Figure 9,B). The tentacles are small, 28 in number in the largest specimen. There is no distinctly marked siphonoglyph, but its cilia are apparently stronger than in other parts of the actinopharynx, the mesoglea of which contains rounded granulous cells. There are 28 mesenteries, regularly arranged. The perfect mesenteries are thin, the imperfect thick

and rounded, their mesoglea containing numerous granulous cells, usually strongly packed and probably lying in canals, but owing to the smallness of the mesenteries it was difficult to observe and it could not be determined that there was actually a canal system. The longitudinal and parietobasilar muscles form a straight lamella. The specimens are sterile. The nematocysts of the tentacles are microbasic *b*-mastigophors, 18.3–22.6 x 2.8–3.5 μ; those of the actinopharynx *b*-mastigophors, 31–33.8 x ca. 4 μ; those of the filaments partly microbasic *p*-mastigophors, 17–19.7 x 3.5–4.2 (5) μ, partly *b*-mastigophors, 28.2–38.4 x 4.2–5 μ; partly holotrichs (only one nematocyst found), 25.4 x 10 μ. The sparseness of the holotrichs may possibly be characteristic of the species.

Length of the largest polyp, 1.2 cm., diameter at the margin, 0.5–0.4 cm.

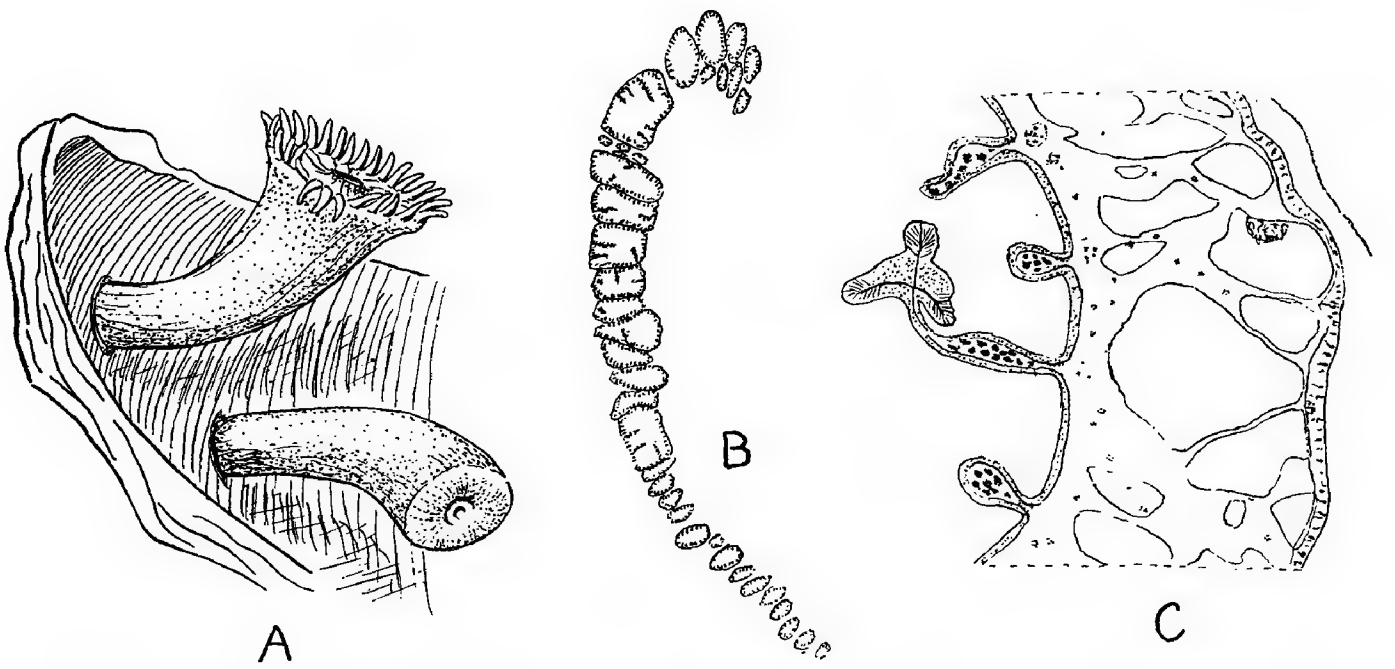

FIGURE 9

Palythoa texaensis n. sp.; A, sketch of living individuals on bit of old shell; B, sphincter, C, section of column wall showing structure of mesoglea.

Order CERIANTHARIA

Family CERIANTHIDAE

Ceriantheomorphe brasiliensis Carlgren

Plate IV.

Ceriantheomorphe brasiliensis Carlgren, 1931, p. 2, figs. 1–5; Carlgren, 1940, p. 12.

Material examined: 20 miles S. of Port Aransas, Texas, off Corpus Christi Pass, 14 fathoms, Nov. 7, 1945, W. Close, coll.; 1 specimen, in try net; 10 miles north of Huts Bayou, Mexico, 14 fathoms, W. W. Anderson, coll. (upper part of specimen).

These two specimens have been identified with this species although their habitat is far from that of the type. One specimen is well preserved and entire, the other consists of only the upper part of the body with the actinopharynx. Unfortunately the nematocysts of the holotype were not measured, and it is possible that these specimens may

represent another species, but in both cases they are very closely related to the type. The long marginal tentacles are very numerous. The arrangement of the mesenteries and their filaments agrees with that found in the type (see Carlgren, 1931, fig. 2), except that the plectocraspedon (cnidoglandular tract of the filaments) of the protomesenteries 3 and the metamesenteries B and b are considerably stronger. In both specimens there is a directive labial tentacle present. Four mesenteries are attached to the siphonoglyph in the well preserved specimen, in the other there seem to be more than four, but it is difficult to determine the exact limit of the siphonoglyph. All mesenteries, except probably the youngest in the multiplication-compartment, are fertile. The arrangement and size of the nematocysts in the two samples agree rather well. The nematocysts of the incomplete specimen are given in parentheses. The nematocysts of the column are partly atrichs, very common, 37–69 x 9–21 μ (25.5–59 x 6–21 μ), partly fairly common holotrichs, 49–56.5 x 10–11.3 μ (44–60.5 x 8.5–12 μ partly hoplotelic *b*-mastigophors, 29.5 –46.5 x 7–8.5 μ (31–42.3 x 5.5.–10 μ), partly *b*-mastigophors (not hoplotelic), 21–31 x 3.5–4 μ (24–35 x 4 μ); those of the marginal tentacles partly hoplotelic *b*-mastigophors, 32.4–42.3 x 5–10 μ (32.4–42.3 (70) x 5–5.6 (10) μ), partly not-hoplotelic *b*-mastigophors, 22.6–26.8 x 3–4 μ (19.7–26.8 x 2.8–3.5 μ), partly a few atrichs (33.8–42.7 x 6.3–11.3 μ); those of the labial tentacles partly hoplotelic *b*-mastigophors, 36.7–53.6 x 4.5–10 μ (29.6–43.7 x 4.2–7.8 μ), partly not-hoplotelic *b*-mastigophors, 19.7–25.4 x 3 μ (19.7–26 x 3.5 μ); those of the actinopharynx partly hoplotelic *b*-mastigophors, 38–63.5 x 5–10 μ (38–52 x 5–10 μ), partly not-hoplotelic *b*-mastigophors 26.8–35.2 x 4 μ (22.5–38 x 3.5–4.2 μ), partly atrichs. 41–53.6 x 6.3–8.5 μ (31–38 x 5.6–7 μ); those of the plectocraspedon hoplotelic *b*-mastigophors, partly 18.3–31 (42.3) x 4.5–7 μ, partly 21 x 3.5 μ; those of the orthocraspedon (ciliated tracts), hoplotelic *b*-mastigophors (rare), 46.5–63.5 x 8.5–12 μ. The smallest, not hoplotelic *b*-mastigophors have a short shaft, the hoplotelic, larger mastigophors (probably two sorts) have a long shaft or one of intermediate length.

The complete specimen is 21 cm. long, about 4 cm. in largest diameter, the marginal tentacles up to 6 cm. long.

Color: (Of the complete specimen) Preserved, the column and actinopharynx are olive brown, oral disc yellowish brown, the tentacles colorless. This specimen, when freshly dead, was a rich sepia brown on the column with brown striping on the outer parts of the tentacles; the inner tentacles were bright salmon (See Pl. IV).

Distribution: Previously known from St. Sebastian, Brazil.

Remarks: Cary (1906) and other workers at the old Gulf Biologic Station at Cameron, reported colonies of a *Cerianthus* on the Chandeleur Islands. Unfortunately the animal has not been collected recently, and it is not known whether the colonies are still extant, and the identity of the species cannot be ascertained at this time. The burrowing habit of these animals makes it difficult to collect them with ordinary gear, and it is possible that they may be more abundant than these collections indicate. The occurrence of colonies of cerianthids, which may form vertical burrows over an inch in diameter and perhaps two feet deep, lined with mucous sheaths. should have noticeable effects on layering of sediments. Under certain conditions. the tube might become filled with a sediment different from that in which the tube is formed following the death of the animal. This would result in a long, core-like cast.

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PLATE I

Upper left: *Anthopleura krebsi* (Duch. et Mich.); upper right: *Bunodactis texaensis* n. sp.; lower: *Bunodosoma cavernata* (Bosc), oral view of typical coloration and lateral view of another color phase.

PLATE II

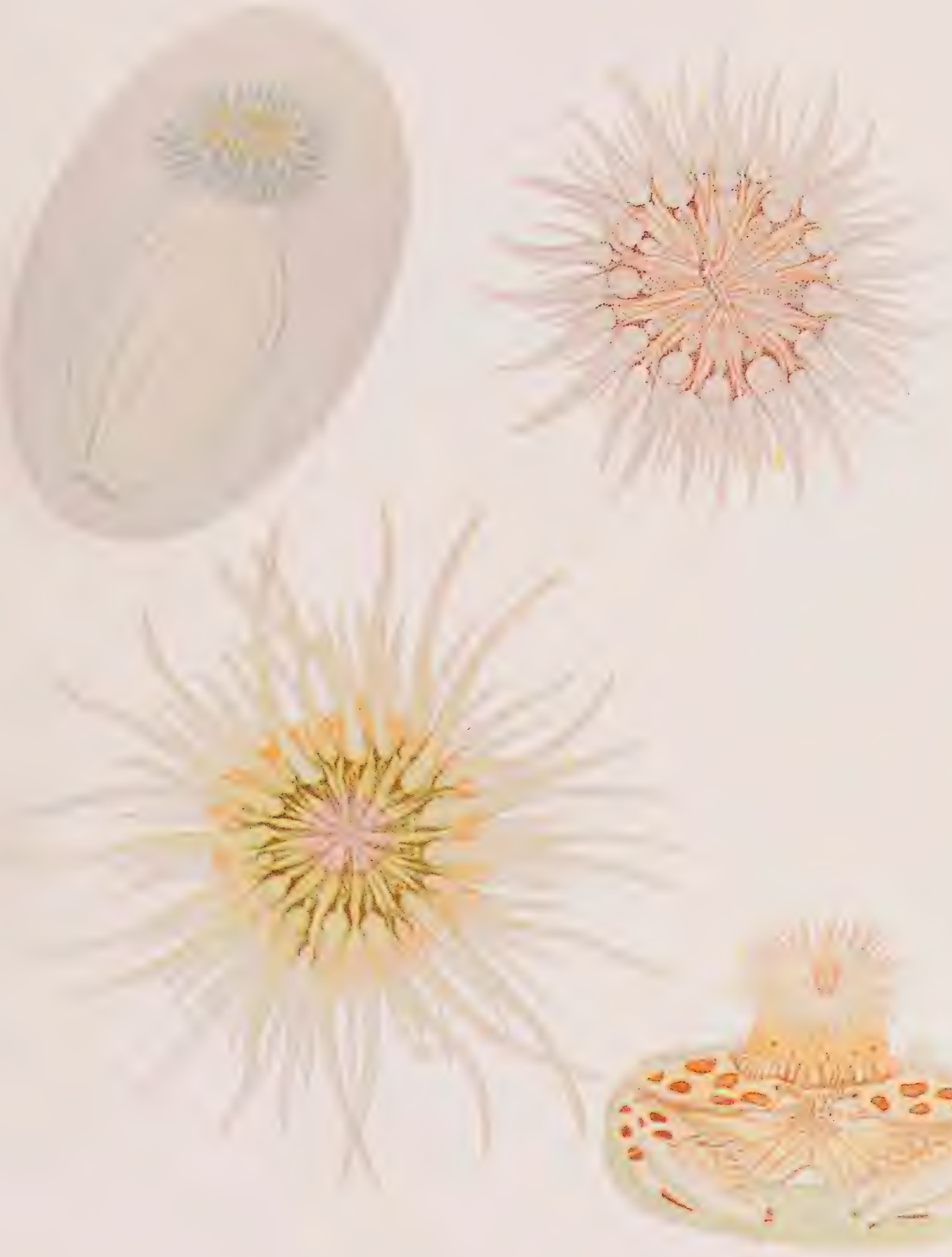
Upper left: *Paranthus rapiformis* (Verrill); upper right: *P. rapiformis*, disc of small individual from Port Isabel; lower left: disc of *Botryon tuberculataus* n. gen. et sp.; lower right: *Calliactis tricolor* (Lesueur) on carapace of *Hepatus epheliticus*.

PLATE III

Aiptasia pallida (Verrill); specimens from South Bay, Port Isabel.

PLATE IV

Upper: *Aiptasiomorpha luciae* (Verrill); lower left: *Anemonia sargassensis* Hargitt, lower right: *Ceriantheomorphe brasiliensis* Carlgren.



Some Nematodes Parasitic in Marine Fishes*

By

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*Studies from the Department of Zoology, University of Nebraska, No. 258.

The nematodes reported in this study were collected from marine fishes obtained in several localities in both Atlantic and Pacific Oceans. Collections from the Atlantic were made at Tortugas, Florida and Beaufort, North Carolina, while Pacific localities include San Juan Island, Puget Sound, Washington; Honolulu, Hawaii; and New Zealand. The nematodes from Puget Sound were collected by the author. All other collections, except as otherwise indicated, were made by Dr. H. W. Manter or by one of his students, Miss Mary L. Hanson, who collected the Hawaiian specimens. To these individuals the author acknowledges his indebtedness. Further grateful acknowledgment is made to Dr. H. W. Manter, under whose direction the work was done, for his helpful suggestions and encouragement.

Fifteen species of nematodes are reported from sixteen marine fishes. Ten new species are described. Holotype specimens, and in some cases paratype specimens, of new species will be deposited in the U. S. National Museum.

ASCARIDAE Baird, 1853

Stomachinae Johnston and Mawson, 1945

1. **Contracaecum melichthysi** new species

Plate I, Figs. 1 to 11.

Host: Melichthys buniva (Lacépède), trigger-fish
Location: Intestine
Locality: Honolulu, Hawaii

This species was obtained from four host individuals, the number of worms present per host ranging from 32 (19 females and 13 males) to 4 (1 female and 3 males).

Specific diagnosis: (Measurements are based on 5 mature males and 5 mature females.)

Males 27.7 to 67.5 mm. long, 0.70 to 1.38 mm. in maximum width. Females 47.5 to 86.0 mm. long, 1.10 to 2.05 mm. in maximum width. Body width at base of lips is 0.36 to 0.57 mm. in males, 0.47 to 0.86 mm. in females. Width at posterior end of esophagus increases from 0.58 to 1.01 mm. in males and 0.83 to 1.54 mm. in females. Cuticula marked by inconspicuous transverse annulations, 6.8 to 8.7 μ apart. Lips elongate, 0.49 to 0.81 mm. long and 0.32 to 0.97 mm. wide bearing wide, transparent postero-lateral cuticular flanges, more or less triangular in shape. Narrowing of these flanges anteriorly produces a constriction dividing the lips into anterior and posterior regions. Dorsal lip differs from sub-ventral lips in having a deep, median anterior indentation. Lip peduncles narrow, 0.056 to 0.110 mm. in width. From the peduncle the lip pulp widens very gradually as it extends anteriorly through the lip. Pulp of dorsal lip indented anteriorly, forming two antero-lateral rounded lobes which are not apparent in pulp of sub-ventral lips (Figs. 1 and 3). Anteriorly, the inner cuticular lining of lips is formed into a series of rounded interlocking ridges and depressions (Fig. 4). Two large, readily seen papillae arise laterally near anterior end of pulp of dorsal lip; on each of sub-ventral lips but one of these papillae is present, located ventrad from median line of lip. At approximately corresponding position of other (laterad) side of lip is a small, barely detectible papilla, near

which is a small similar appearing structure which presumably represents an amphid (Fig. 3). Interlabia 0.14 to 0.27 mm. long, their tips covered by narrow, transparent cuticular ridges.

Claviform esophagus of males, including ventriculus, 4.02 to 6.81 mm. long; 0.46 to 0.68 mm. in maximum width. Irregularly shaped ventriculus 0.26 to 0.52 mm. long, 0.29 to 0.40 mm. wide. Ventricular appendix extends posteriorly 0.98 to 1.46 mm.; intestinal cecum extends anteriorly 0.25 to 0.73 mm., or about one-tenth the length of esophagus. Esophagus of females, including ventriculus, 5.30 to 8.20 mm. long, 0.60 to 1.07 mm. in maximum width. Ventriculus 0.39 to 0.73 mm. long, 0.29 to 0.52 mm. wide. Esophageal appendix 0.98 to 2.12 mm. long; intestinal cecum 0.32 to 0.68 mm. long.

Nerve ring 0.94 to 1.33 mm. from anterior in males and 0.89 to 1.71 mm. from anterior in females. Excretory pore always within 0.1 mm. posterior to nerve ring. Rectum of females 0.52 to 0.96 mm. long, provided with well developed rectal glands (Fig. 10).

Tail of males and females 0.15 to 0.18 mm. and 0.63 to 1.06 mm. long respectively. In both sexes it terminates in a conical, retractile point covered with minute spines. Posterior 2 to 3 mm. of males sharply curved ventrad. Convoluted testis of male reaches to within 5.02 to 18.4 mm. of anterior end. Seminal vesicle 5.70 to 17.94 mm. long; ejaculatory duct 2.28 to 4.89 mm. long. Spicules subequal, 2.80 to 4.23 mm. long, bearing transparent alae somewhat wider than main supporting shaft and forming small lobe-like extensions covering distal tips (Fig. 7). Difference in lengths of the two spicules in an individual specimen never exceeded 0.27 mm., with the exception of one male in which the spicule measurements were 2.56 and 2.95 mm. It is likely that in this case the greater difference was due to breakage of the shorter spicule, since its distal end seemed abnormal. Neither right nor left spicule was consistently the longer. In an immature male, 15.5 mm. long, the spicules measured only 1.45 and 1.46 mm. From 22 to 26 pairs of pre-anal papillae present, the anteriormost being 1.96 to 3.99 mm. from the cloacal opening. One pair ad-anal papillae at posterior border of cloacal opening (Fig. 6). No post-anal papillae visible, except in the 67.5 mm. male, which possessed three minute pairs approximately evenly spaced between cloacal opening and posterior end. Pre-anal papillae arranged in the manner characteristic of the genus, the anterior ones being larger and more lateral in position; nearer the cloacal opening they become smaller and nearer the mid-ventral line. Distance between successive pairs varies from 33 μ near the cloacal opening to 240 μ farther anteriorly.

Vulva of female 12.6 to 20.58 mm., or about one-fourth of body length, from anteror end. Vagina relatively narrow, extending posteriorly from vulva, its anterior region having thick muscular walls (Fig. 9). In a 62 mm. female the vagina measured 3.03 mm., and was continuous posteriorly with a single uterine tube, 8.01 mm. in length. This in turn gave rise to two parallel uteri which continue posteriorly for a distance of 11.8 mm., where each joins an oviduct which loops back anteriorly. The ovaries extend anteriorly to within 3 mm. from the vulva, there bending back posteriorly and reaching a point 2.46 to 19.3 mm. from the posterior end. Eggs thin shelled, measure 75 to 82 μ by 48 to 55 μ, and contain segmenting embryos (Fig. 11).

Comparisons:

Contracaecum melichthysi and *C. ogcocephali* are obviously closely related, their unique lip structure setting them apart from other species in the genus. In both, the lips are elongate, have very narrow peduncles, and exhibit pronounced constrictions which divide the lips into anterior and posterior regions. Additional evidence of their relationship is seen in the short intestinal cecum possessed by both.

Chief among the differences between these species are (1) the presence in *C. melichthysi* of a deep median indentation at the anterior end of the dorsal lip and the anterior lateral extensions of the pulp of that lip which form two prominent rounded lobes, (2) the much greater lip dimensions in *C. melichthysi* in porportion to body size (over twice as large), (3) the slightly greater relative width of the lips, and (4) the much greater length of the spicules (about five times as long).

2. **Contracaecum ogcocephali** new species

Plate I, Figs. 12 to 17.

Host: Ogcocephalus radiatus (Mitchill), bat-fish

Location: Intestine

Locality: Tortugas, Florida

B. B. Rees originally studied and described this species under the name *C. ogocephali* in an unpublished thesis (Department of Zoology, University of Nebraska, 1941). His data and figures, with a few minor corrections and additions, are used in the following description.

Specific diagnosis:

Length of males 20.0 to 30.0 mm., maximum width 0.40 to 0.50 mm.; length of females 30.0 to 55.0 mm., maximum width 0.46 to 0.71 mm. Distance between cuticular annulations varies from 29 to 37 μ. Lips unusually elongate, about twice as long as wide, with narrow peduncles. Postero-lateral cuticular flanges extend along posterior two-thirds of lips. Conspicuous papillae located about 0.03 mm. from anterior ends of lips, two on the dorsal lip and one on each of the sub-ventrals. Inner anterior surfaces of lips possess interlocking ridges and grooves (Figs. 12 and 13).

In a 26.0 mm. male the esophagus is 3.76 mm. long and 0.20 mm. wide, its ventriculus 0.18 mm. long and 0.16 mm. wide. Ventricular appendix and intestinal cecum 1.30 mm. and 0.24 mm. long respectively. Excretory pore opens immediately posterior to nerve ring, which is 0.58 mm. from anterior end. Tail 0.13 mm. long. In a 52.4 mm. female the esophagus is 4.74 mm. long and 0.24 mm. wide, its ventriculus 0.24 mm. long and 0.21 mm. wide. Ventricular appendix and intestinal cecum 1.71 mm. and 0.33 mm. long respectively (Fig. 14). Nerve ring and excretory pore 0.72 mm. and 0.75 mm. respectively from anterior end. In a 30 mm. female, lengths of rectum and tail are 0.22 mm. and 0.37 mm. respectively (Fig. 16).

Spicules of male equal, 0.52 to 0.66 mm. long. Pre-anal papillae number 18 to 26 pairs; post-anal papillae 1 to 2 pairs (Fig. 15).

Vulva of 52.4 mm. female located 14.4 mm. from anterior end. Vagina and uteri directed posteriorly. Eggs thin-shelled, 59 to 68 μ long and 52 to 56 μ wide, and contain segmenting embryos (Fig. 17).

Comparisons:

The species of *Contracaecum* which most closely resembles *C. ogcocephali* is *C. melichthysi*. These two forms are distinguished from all other species in the genus particularly by their elongated lips, the unusual lip outline, and their short intestinal ceca. Differences between the two species are enumerated on page 177.

3. **Contracaecum chaunaxi** new species

Plate II, Figs. 18 to 22.

Host: Chaunax sp.

Location: Intestine

Locality: Tortugas, Florida

Specific diagnosis: (Based on one adult male)

Length 36.9 mm., with posterior 5.0 mm. coiled ventrally to form a complete loop; width of head 0.24 mm.; width immediately posterior to head 0.31 mm.; width at posterior end of esophagus 0.50 mm.; maximum width, at about 2.5 mm. from posterior end, 0.81 mm. Esophagus 3.05 mm. long, 0.31 mm. in maximum width; ventriculus of esophagus 0.21 mm. long and 0.24 mm. wide. Ventricular appendix and intestinal cecum 1.51 mm. and 1.20 mm. long respectively (Fig. 21). Nerve ring and excretory pore 0.77 mm. and 0.83 mm. from anterior end respectively. Cuticular markings very faint, about 1.8 μ apart.

Lips as wide or nearly as wide at base as at widest point. Lip pulp narrows slightly from posterior to anterior; no anterior rounded projections of pulp apparent. Narrow lateral flanges extend along entire length of lips, widening only slightly midway along lip. Two large papillae located at antero-lateral margin of dorsal lip, their tips extending slightly beyond edge of lip. Similar papillae, located further posteriorly, are found on ventrad sides of each of sub-ventral lips; at corresponding level on dorsad sides of these lips a very small papilla is visible, being most readily apparent in dorsal or ventral views of head. Lips bear interlocking ridges and grooves on anterior inner surfaces. Interlabia 0.063 mm. long (Figs. 18, 19, and 20).

Testis begins 8.61 mm. from anterior end, extends posteriorly about 20 mm. Seminal vesicle and ejaculatory duct 5.13 mm. and 2.93 mm. long respectively. Both spicules had been broken off at cloacal opening, the portions remaining within the body measuring 1.1 and 1.0 mm. Tail 0.16 mm. long, its tip bearing fine spine-like projections. Seventeen pairs of pre-anal, three pairs of ad-anal, and one pair of post-anal papillae present, the anteriormost of pre-anals being 1.76 mm. from anus. Distance between pre-anal papillae ranges from 0.04 mm. near anus to 0.22 mm. further anteriorly. Middle pair of ad-anals located nearer mid-ventral line than other two. Post-anal pair located about midway between anus and tip of tail (Fig. 22).

The same host contained, in the stomach, an immature female nematode also of the genus *Contracaecum*. This specimen was only 14.63 mm. long, and the lips were not sufficiently developed to make possible specific identification. One feature of interest was the great length of the ventricular appendix, which measured 2.12 mm., whereas the esophagus itself was only 1.90 mm. long.

Comparisons:

The lip structure of *C. chaunaxi* resembles most nearly that of *C. melanogrammi* and *C. magnum,* two species described by Smedley (1934). The former is from a haddock, *Melanogrammus aeglefinus* (Linnaeus) taken at the Atlantic Biological Station, St. Andrews, New Brunswick. The latter was collected from three different hosts, namely *Ophiodon elongatus* Girard, *Leptocottus armatus* Girard, and *Apodichthys flavidus* Girard, all taken at the Pacific Biological Station at Nanaimo, Vancouver Island, British Columbia. In these three *Contracaecum* species the lips are relatively uniform in width through their length, their peduncles being relatively wide and their flanges not forming any pronounced lateral extensions; the head is wider than long; and the dorsal lip is slightly shorter than the subventrals. *C. chaunaxi* can be distinguished from both of Smedley's species, however, (1) by the location of its dorsal lip papillae at the extreme anterior (as seen from the side) rather than further posteriorly on the lip, (2) by the fact that its ventricular appendix substantially exceeds the intestinal cecum in length rather than the reverse condition being true, and (3) by the absence of two rounded projections at the anterior of the pulp of the lips, structures which are conspicuous in the lips of Smedley's species. In the description of *C. magnum,* Smedley mentions that in addition to the single cephalic papilla present on each sub-ventral lip, there are "two large round papillae with clear cuticular borders, set laterally on the lower part of the sub-ventral lips." Such structures, whatever their correct interpretation may be, are not present in *C. chaunaxi.*

4. **Contracaecum histiophori** Yamaguti, 1935

Plates II and III, Figs. 23 to 32.

Host: Istiophorus americanus (Cuvier and Valenciennes), sailfish

Location: Stomach

Locality: Florida coast

These nematodes, collected in September 1951 by W. H. Brady, were forwarded to Dr. H. W. Manter at the University of Nebraska, who made them available to the author for study. Of 26 specimens, 9 were males (6 mature, 3 immature) and 17 were females (3 mature, 14 immature); in addition numerous fragmentary specimens were present.

In many respects these nematodes resemble *Contracaecum incurvum* (Rudolphi, 1819) Baylis and Daubney, 1922, of which the type host is a sword-fish, *Xiphias gladius* Linnaeus, which belongs to a family closely related to sailfishes. Baylis (1936) states that he and Daubney have also recorded "adult but probably not full-grown specimens" of *C. incurvum* from the stomach of the peacock-fish, *Istiophorus gladius,* taken from Indian waters.

Yamaguti in 1935 named a new species, *Contracaecum histiophori,* which he collected from the intestine of *"Histiophorus" orientalis* from Toyama Bay, Japan. Although Yamaguti's description is rather brief, the author feels that the specimens from the Florida sailfish are identical with this species. Yamaguti points out that *C. histiophori* differs from *C. incurvum* "chiefly in the length of the body and in the position of the nerve ring and vulva." Additional differences noted in the present

study are the presence, in *C. histiophori*, of much narrower lip peduncles, an esophageal appendix which is always considerably longer than the esophagus, and slightly larger eggs.

Yamaguti's very brief description of *C. histiophori* is based on three specimens, a mature female, an immature female, and an immature male, and it includes but a single figure (the posterior end of the immature male). The only wide discrepancy between his description and my specimens was noted in spicule length. He gives 2.15 mm. as the length of the spicules of the immature male which was 24.0 mm. long. The shortest of the immature males among my specimens, 31.0 mm. long, had spicules 3.6 mm. in length. However, in view of the great variation in spicule length shown within other species of *Contracaecum*, this feature alone did not seem to constitute sufficient basis for designating these two forms as separate species. The following description supplements that of Yamaguti, and provides the first description of mature males. Measurements are based on three mature males and two mature females.

Length of females 57.8 to 84.5 mm.; of males 42.5 to 48.0 mm. Width of females immediately posterior to lips 0.29 to 0.34 mm., at posterior end of esophagus 0.61 to 0.75 mm., at vulva 0.69 to 0.91 mm., and at about one-third of body length from posterior (maximum) 0.93 to 1.46 mm. Width of males immediately posterior to lips 0.24 to 0.27 mm., at posterior end of esophagus 0.54 to 0.61 mm., and one-third to one-fourth of body length from posterior (maximum) 0.72 to 1.02 mm. Diameter of head 0.26 to 0.36 mm. in females and 0.24 to 0.26 mm. in males.

Lip outline shows close resemblance to *C. incurvum*, chief difference being extreme narrowness of lip peduncle, which is from 14 to 37 μ wide. Lips 0.14 to 0.24 mm. long and 0.19 to 0.27 mm. wide, the greater width being due to presence of wide postero-lateral flanges. Pulp of symmetrical dorsal lip forms a pair of anteriorly projecting rounded bulbs and a pair projecting laterally, each of the latter bearing a papilla near its extremity (Fig. 23). Sub-ventral lips show typical asymmetry, each bearing one papilla on the ventrad side, a large anterior pulp swelling on the dorsad side (Fig. 25). Arrangement of interlocking ridges and grooves on anterior inner surfaces of lips is best seen in *en face* view (Fig. 26). Length of interlabia 0.60 to 0.75 mm. Conspicuous cervical alae present, 3.17 to 3.20 mm. long in females, 2.48 to 3.05 mm. long in males, attaining a width of 0.08 mm. Cervical papillae near level of excretory pore, 0.79 and 0.73 mm. from anterior on right and left sides respectively of a 48 mm. male. Cuticular annulations 6.4 μ apart near excretory pore, 17 μ apart posterior to midbody.

Esophagus, including ventriculus, 4.11 to 5.20 mm. long and 0.27 to 0.31 mm. wide in females, 3.26 to 3.98 mm. long and 0.19 to 0.26 mm. wide in males. Ventriculus 0.19 to 0.20 mm. long and 0.23 to 0.29 mm. wide in females, 0.16 to 0.21 mm. long and 0.18 to 0.24 mm. wide in males. Intestinal cecum of females 2.77 to 3.71 mm. long, of males 2.01 to 2.86 mm.; ventricular appendix 4.89 to 6.44 mm. long in females, 4.60 to 6.14 mm. long in males. Ventricular appendix considerably exceeded esophagus in length in all specimens studied, a unique feature among *Contracaecum* species; differences between their lengths ranged from 0.78 to 2.16 mm. Nerve ring and excretory pore 0.72 to 0.81 mm. and 0.85 to 0.95 mm. respectively from anterior end in females, 0.58 to 0.68 and 0.68 to 0.88 mm. from anterior end in males. Tail 0.42 to 0.57 mm. long in females, 0.18 to 0.22 mm. long in males.

Vulva protrudes slightly and bears several small papilliform structures (Fig. 30). It is located a short distance posterior to midbody in all specimens, this distance decreasing as specimens become more gravid. Vulva of 84.5 mm. gravid female 44.0 mm. from anterior end; that of 57.8 mm. female 32.5 mm. from anterior end. Among other *Contracaecum* species the vulva is typically located well anterior to midbody. Vagina of 84.5 mm. female extends 4.14 mm. posteriorly; uterus continues for 34.1 mm., dividing into two branches. Ovaries extend back anteriorly to 0.61 mm. from vulva, then posteriorly, terminating 1.1 mm. anterior to anus. Eggs from uterus thin shelled, contain multicellular embryos, and measure 71 to 82 μ by 59 to 67 μ (Fig. 31).

Testis of male originates 14.7 to 17.4 mm. from anterior end and extends posteriorly 15.2 to 20.2 mm. Seminal vesicle and ejaculatory duct 6.2 to 8.3 mm. and 3.31 to 3.86 mm. long respectively. Spicules slender, sub-equal, 4.75 to 5.34 mm. long, difference in their lengths in a single specimen ranging from 0.09 to 0.37 mm. They bear transparent alate processes and terminate distally in an extremely fine point (Fig. 29). Fifteen pairs pre-anal papillae present, the anteriormost being 2.99 to 3.18 mm. anterior to anus. Distance between successive pairs as great as 0.75 mm. anteriorly and as little as 0.02 mm. near anus. Nearing the anus the papillae become progessively smaller and located nearer the mid-ventral line. Ad-anal papillae lacking; four pairs post-anal papillae present, the first and third ventral, the second and fourth lateral (Fig. 27). A bizarre feature of the posterior of the male is the presence, on the ventral surface, of pronounced transverse cuticular crests, ranging in width from 11 to 56 μ, beginning 0.24 mm. anterior to the anus and extending anteriorly about 3.50 mm. Each transverse crest is marked by a series of longitudinal lines, the distance between these lines ranging from about 4 to 18 μ (Fig. 28). Yamaguti has mentioned these crests in his description of *C. histiophori*, referring to them as "numerous longitudinal rows of sharply incised cuticular ridges extending from behind the anterior end of the spicules to 0.5 mm. in front of the cloaca."

Baylis (1936), in redescribing *C. incurvum*, states that the ventral surface of the male, "from about 0.7 mm. in front of the cloaca forward for about 2 mm., has the cuticle raised into pronounced longitudinal ridges, interrupted by transverse grooves at intervals of 0.03 mm." It is of interest to note that the two species *C. histiophori* and *C. incurvum*, whose fish hosts represent the closely related families *Istiophoridae* (sail-fishes) and *Xiphiidae* (sword-fishes) respectively, are apparently the only species from fish hosts in the genus *Contracaecum* with such special development of the cuticula in the posterior ventral region of the male.

5. **Contracaecum habena** (Linton, 1900) Linton, 1934

Host: Opsanus tau (Linnaeus), toad-fish

Location: Stomach and intestine

Locality: Beaufort, North Carolina

Opsanus tau is the type host of this species, which has been redescribed by Chandler (1943).

6. **Contracaecum aduncum** (Rudolphi, 1802) Baylis, 1923

Host: Sebastodes caurinus (Richardson), copper rockfish

Location: Stomach

Locality: San Juan Island, Washington

This constitutes a new host record for *C. aduncum*, bringing to 45 the number of fish hosts from which this widespread species has been reported.

7. **Heterotyphlum eurycheilum** new species

Plate III, Figs. 33 to 40.

Host: Promicrops itaiara (Lichtenstein), jewfish

Location: Stomach and intestine

Locality: Tortugas, Florida

One mature and six immature females of this species were collected. Although showing close relationship to the genus *Contracaecum* by virtue of the possession of both a ventricular appendix and an intestinal cecum, it is impossible to include these specimens in that genus since they completely lack interlabia. In the subfamily Stomachinae the only other genus possessing a ventricular appendix and an intestinal cecum while lacking prominent cuticular annulations and dentigerous ridges or teeth on the lips is the genus *Heterotyphlum* Spaul, 1927. In addition to the presence of a ventricular appendix and an intestinal cecum, Spaul mentions, in his diagnosis of *Heterotyphlum*, the lack of interlabia, the lack of dentigerous ridges, an asymmetrical condition of the lips, the location of the vulva in the anterior half of the body, an unusual structural feature of the ventricular appendix, the anterior half of which is slender and the posterior half enlarged.

In my specimens the ventricular appendix is of the conventional type, narrowing very gradually from anterior to posterior rather than having a posterior enlargement. However, they are in agreement with all the other above mentioned characteristics in Spaul's diagnosis of *Heterotyphlum* and, since variation in the structure of the ventricular appendix alone can hardly be considered to be of more than specific value, it seems advisable to modify Spaul's original diagnosis of *Heterotyphlum* to allow inclusion of forms either with or without the posterior enlargement of this structure, thus permitting my specimens to be placed in the genus. The specific name *H. eurycheilum* is from *eury* = wide and *cheilos* = lip, and refers to the relatively great width of the lips caused by the posterior lateral flanges.

Specific diagnosis: (Measurements are based on the one adult female and one of the immature females in which, although the genitalia were formed, no eggs were present. The measurements of the adult female are followed in parentheses by those of the immature female.)

Length 53.9 mm. (32.5 mm.); width of head 0.52 mm. (0.42 mm.), immediately posterior to head 0.58 mm. (0.42 mm.), and at posterior end of esophagus 1.17 mm. (0.84 mm.); maximum width, at about 10 mm. from posterior, 1.37 mm. (0.96 mm). Esophagus 6.52 mm. (5.49 mm.) long representing 1/6 to 1/8 of body length, and 0.84 mm. (0.65 mm.) in maximum width. Ventriculus of esophagus 0.39 mm. (0.34 mm.) long and 0.62 mm. (0.47 mm.) wide. Ventricular appendix 1.02 mm. (0.91 mm.) long and intestinal cecum 0.55 mm. (0.52 mm) long (Fig. 37). Distance between annulations marking the cuticula varies from 9.3 to 13.3 μ.

Lip outline constitutes one of the most distinctive characteristics of the species. Basal portion of lip, representing 2/5 of lip length, is widened to twice or more the width of the anterior region due to presence of spatuliform lateral flanges. Lips 0.31 mm. (0.23 mm.) long; 0.44 mm. (0.36 mm.) wide in region of posterior flanges and 0.21 mm. (0.18 mm.) wide in anterior region as well as at lip peduncle. Lip pulp outline gives evidence of series of three pairs of bulb-like swellings from posterior to anterior. In symmetrical dorsal lip, which shows considerable difference in structure from sub-ventral lips, middle pair of pulp swellings protrudes laterally, each swelling bearing near its extremity a large papilla, at about level of anterior margin of lateral flanges (Fig. 33). In subventral lips the contours of pulp swellings are not so distinct, the middle pair not protruding laterally. The middle swelling adjacent to dorsal lip is considerably larger than that on the ventrad side, extending further anteriorly as well as outward, away from the longitudinal axis. The disparity in size of these pulp swellings causes sub-ventral lips to be asymmetrical, and gives the outline of the entire head a more or less rectangular appearance. Each of sub-ventral lips bears a single large papilla on the ventrad side at a level corresponding to that of the dorsal lip papillae (Figs. 34 and 35). An *en face* view of lips shows presence, on inner anterior surface, of interlocking projections (4 on each lip) and depressions (Fig. 36).

Nerve ring 0.68 mm. (0.73 mm.) from anterior; excretory pore a short distance posterior to nerve ring (0.18 mm. in specimen in which nerve ring was 0.65 mm. from anterior). Rectum 0.49 mm. (0.41 mm.) long, tail 0.89 mm. (0.67 mm.) long (Fig. 39).

Vulva 18.0 mm. (11.0 mm.), or one-third of body length, from anterior end. Vagina, 3.1 mm. long in mature female, makes one transverse loop before joining single portion of uterus, which extends posteriorly 2.2 mm (Fig. 40). Two uterine branches continue posteriorly 9.7 mm. Ovaries extend back anteriorly to 0.69 mm. from vulva, then posteriorly, terminating 3.92 mm. from posterior end. Eggs in uterus have smooth, thin shells, contain unsegmented ova, and measure 45 to 52 μ by 33 to 37 μ (Fig. 38).

Male unknown.

Comparisons:

The type of the genus, *Heterotyphlum himantolophi* Spaul, 1927 was collected from the deep sea angler fish, *Himantolophus groenlandicus*, "probably from Iceland." No statement is made as to the location of the worms in the host. No additions to the genus have been made since the description of the type, and *Heterotyphlum eurycheilum* thus represents the second species. Several differences, in addition to the previously mentioned difference in the structure of the ventricular appendix, are apparent between these two species.

In *H. himantolophi* the spatuliform lateral flanges of the lips, which are so conspicuous in *H. eurycheilum*, are lacking; the width is much greater in proportion to the length; the esophagus is longer (2 to 3 times) in proportion to the length; both intestinal cecum and ventricular appendix are longer, the latter being about six times as long; and the dimensions of the eggs are much greater.

Spaul states that in *H. himantolophi* "there are three asymmetrical lips having marginal cuticular extensions," making no mention of any difference existing be-

tween the sub-ventral lips and the dorsal lip other than that "the dorsal lip shows a tendency to be smaller than the ventro-lateral lips." However the figure he gives, as well as the measurements, are designated as being of the sub-ventral lips, and it seems possible that he may not have observed the dorsal lip in a view which would reveal its symmetry or asymmetry. This possibility is made more likely by the fact that, in studying such relatively large worms as these ascarids, it is practically always necessary, in order to obtain a dorsal view of the head, to use a small anterior portion which can be rolled about in a temporary mount by moving the cover glass. In describing the lip papillae Spaul states that "each lip has apparently two unequal papillae, the larger lozenge-shaped, the smaller a rounded or conical process." If this interpretation is correct, it would represent another difference between the two species, since in *H. eurycheilum* the dorsal lip bears two equal papillae and the sub-ventrals one each. The large expansions of the pulp on the dorsad side of the sub-ventral lips, which produce the asymmetry of these lips, bear no discernible papillae.

8. **Raphidascaris lutiani** new species

Plate III, Figs. 41 to 49.

Host: Lutianus analis (Cuvier and Valenciennes), mutton-fish

Location: Intestine

Locality: Tortugas, Florida

Specific diagnosis: (Based on one mature female and three mature males.)

Length of female 72.1 mm.; width of head 0.59 mm., immediately posterior to head 0.65 mm., at posterior end of esophagus 1.24 mm., and at midbody (maximum width) 2.04 mm. Length of males 32.1 to 50.5 mm.; width of head 0.39 to 0.48 mm., immediately posterior to head 0.50 to 0.52 mm., at posterior end of esophagus 0.96 to 1.25 mm., and maximum width (1/2 to 2/3 of body length from anterior end) 1.33 to 1.52 mm.

Dorsal lip of 32.1 mm. male 0.19 mm long and 0.22 mm. wide; sub-ventral lips 0.20 mm. long and 0.22 mm. wide. Lips more or less square in outline, relatively uniform in width through their length, with no narrowed region, or peduncle, at the base. Lateral cuticular flanges narrow. Dorsal lip symmetrical, its pulp forming two outward and laterally directed bulb-like protrusions about midway along length, each protrusion bearing a papilla at its extremity. Pulp divided distally into two lobes by an inconspicuous median indentation. Sub-ventral lips asymmetrical, with pulp at anterior of dorsad side greatly expanded (away from longitudinal axis), these expansions giving the entire head, in dorsal or ventral view, a square, truncated appearance. On ventrad side of these lips is a bulb-like pulp protrusion, similar to those of dorsal lip but more anteriorly than laterally directed, bearing a single papilla. No interlabia present; outline of interlabial space, between margins of adjacent lips, more or less horse-shoe shaped. Inner, lateral, anterior margins of lips bear interlocking grooves and ridges (Figs. 41, 42, 43, and 44).

Esophagus of female 7.53 mm. long, 1.10 mm. in maximum width; ventriculus 0.52 mm. long, 0.88 mm. wide; ventricular appendix 1.93 mm. long. Esophagus of males 0.97 to 5.93 mm. long, 0.63 to 0.78 mm. in maximum width; ventriculus 0.36 to 0.37 mm. long, 0.56 to 0.63 mm. wide; ventricular appendix 1.82 to

2.12 mm. long (Fig. 46). Cuticular annulations 7 to 13 μ apart. Nerve ring 1.02 mm. from anterior in female and 0.86 to 0.93 mm from anterior in males. Excretory pore located a short distance posterior to nerve ring (0.14 mm. in male 50.5 mm. long). Inconspicuous lateral cervical papillae, barely detectable even in dorsal or ventral view, are located at about same level as excretory pore, 1.01 and 1.07 mm. from the anterior end on right and left sides respectively in the 43.2 mm. male. No cervical alae present. Tail 1.61 mm. long in female and 0.44 to 0.57 mm. long in male (Figs. 47 and 49).

Vulva 23.78 mm., or about 1/3 of body length, from anterior end. Vagina short and muscular, 2.21 mm. long, widening abruptly to join uterus, which extends posteriorly as a double tube for 22 mm. (Fig. 48). Ovaries extend to 5.46 mm. anterior to vulva, then back posteriorly, terminating 2.67 mm. from posterior end. Eggs measure 48 to 52 μ by 41 to 43 μ, possess thin, unmarked shells, and contain either unsegmented ova or 2-celled embryos (Fig. 45).

Ejaculatory duct of male 3.89 to 3.94 mm. long; seminal vesicle, a wide tube forming several loops, 6.40 to 7.45 mm. long. Testis reaches to within 4.95 to 6.38 mm. from anterior end. Nine to eleven pairs pre-anal papillae present, all of approximately the same size, the anteriormost being 3.66 mm. from the anus in the 50.5 mm. male. Distance between successive pairs ranges from 0.10 mm. near anus to 0.43 mm. further anteriorly. No ad-anal papillae. Three pairs of evenly spaced post-anal papillae present, the posteriormost about 0.14 mm. from end of tail. Spicules equal, arcuate, relatively heavy-bodied, 1.06 to 1.09 mm. long, 0.065 mm. at the widest point.

Comparisons:

The genus *Raphidascaris* Railliet and Henry, 1915, is distinguishable from other stomachine genera chiefly by the absence of interlabia, dentigerous ridges, and an intestinal cecum, and by the presence of a ventricular appendix. Including *R. lutiani*, the genus contains eleven species, all from fish hosts, and seven from fresh-water fishes. Various important differences serve to distinguish *R. lutiani* from the other ten species. Its size is much greater than that of *R. cayugensis* (Wigdor, 1918); *R. gigi* Fujita, 1938; *R. chirocentri* Yamaguti, 1935; and *R. laurentianus* Richardson, 1937. Its lip outline is much different from that of *R. acus* (Bloch, 1779) Railliet and Henry, 1915 and its spicules are considerably longer than in *R. alius* Lyster, 1940 or *R. brachyurus* (Ward and Magath, 1916). Both spicules and tail are longer than in *R. canadensis* Smedley, 1933. The validity of *R. anchoviellae* Chandler, 1935 and *R. gracillima* (Linstow, 1890) is questionable, since both were described from immature forms, none over 6 mm. long. In *R. anchoviellae* neither the adult lips nor the spicules of the males had been formed, although the reproductive tubes had been developed. Chandler states that "their specific identity is uncertain, since they are immature, but since the adult stage can be obtained by infection experiments, it seems advisable to designate this species by a new name, even though it may subsequently fall into synonymy." *R. gracillima* is described from a single specimen which was apparently so immature that the sex could not be determined, since no statement as to its sex is contained in the description.

9. **Raphidascaroides nipponensis** Yamaguti, 1941

Host: Dactylopterus orientalis (Cuvier), Pacific flying gurnard

Location: Intestine

Locality: Honolulu, Hawaii

This constitutes a new host record for *R. nipponensis*, which had previously been collected by Yamaguti in Japan from *Ateleopus japonicus*, *Zebrias zebrinus*, and *Lophius litulon*.

Yamaguti (1941) states that his new genus, *Raphidascaroides*, "differs from *Raphidascaris* Railliet et Henry, 1915, in the possession of distinct interlabia and from *Paranisakis* Baylis, 1923, in the possession of a ventricular appendix." *Raphidascaris diodonis* Thwaite, 1927, should therefore be transferred to *Raphidasdascaroides*, since it possesses well defined interlabia, producing the following new combination, which brings to two the number of species in *Raphidascaroides:*

Raphidascaroides diodonis (Thwaite, 1927) n. comb.

Synonym: *Raphidascaris diodonis* Thwaite, 1927

Host: *Diodon hystrix* Linnaeus

The descriptions of several other species of *Raphidascaris* do not make clear whether interlabia are present or absent, and an examination of type specimens of these species may show that some of them should also be transferred to *Raphidascaroides*.

10. **Terranova ginglymostomae** new species

Plate IV, Figs. 50 to 63.

Host: Ginglymostoma cirratum (Gmelin), nurse shark

Location: Stomach

Locality: Tortugas, Florida

Four specimens of this new species were collected, among which were one mature female, two mature males, and one immature male, in addition to posterior fragments of two males. Measurements in the following description are based on all specimens with the exception of the immature male.

Specific diagnosis:

Length of males 17.9 to 19.1 mm.; width at posterior end of esophageal ventriculus 0.42 to 0.45 mm.; maximum width, at about 2/3 of body length from anterior end, 0.60 to 0.68 mm. Length of female 22.3 mm.; width at posterior end of esophageal ventriculus 0.60 mm.; maximum width, at about 2/3 of body length from anterior end, 0.91 mm.

Esophagus of males 1.70 to 2.02 mm. long, including posterior ventriculus 0.51 to 0.57 mm. long. Esophagus of female 2.21 mm. long, including posterior ventriculus 0.58 mm. long. Maximum width of anterior muscular portion of esophagus 0.14 to 0.15 mm. in males, 0.14 in female; width of ventriculus 0.16 mm. and 0.19 mm. in males and female respectively. Intestinal cecum extends along esophagus 1.07 to 1.09 in males, 1.12 mm. in female (Fig. 52).

Lips of type characteristic of genus, being poorly demarked from neck region and each bearing a median anterior bidentate projection with dentigerous border. Dorsal lip bears two large papillae near lateral margins; sub-ventrals one large papilla each, on the ventrad side. No interlabia present. A cuticular membrane appears to join sub-ventral lips ventrally (Figs. 50 and 51). Anterior end of two specimens was enclosed in a fibrous sheath, indicating that the worms may anchor themselves by burying the head in the stomach wall of the host.

Narrow lateral alae begin immediately posterior to lips, extending posteriorly to about midbody. Nerve ring close to anterior end, 0.31 to 0.32 mm. in males and 0.32 mm. in female. Small, bulb-shaped cervical papillae of 19.1 mm. male located 0.45 mm. from anterior end (Fig. 53). Excretory pore could be located in none of the specimens; Baylis (1927) states that its usual location in the genus is "just between and behind the bases of the ventrolateral lips." Fine cuticular annulations 3.4 to 4.1 μ apart.

Testis of 17.9 mm. male extends anteriorly to 3.32 mm. from esophageal ventriculus. Seminal vesicle 7.1 mm. long and thick-walled, muscular ejaculatory duct, 1.12 mm. long. Spicules sub-equal, arcuate, and non-alate, are 0.63 to 0.70 mm. long and attain maximum width of 56 μ at proximal end. Transverse sections show that each spicule consists of crescent-shaped halves, with the concave surfaces opposed (Fig. 60). In all males among my specimens the posterior region of the body (1.5 to 2.0 mm.) is bent dorsally (Fig. 54). The tail is curved ventrally. Two rows of conspicuous sub-ventral caudal papillae present, beginning 2.28 to 2.41 mm. anterior to cloacal opening and continuing past that opening. Peduncles of these papillae are 18 to 63 μ long, but are enclosed through most of this length in expansions of the cuticula which form two thick sub-ventral ridges (Figs. 57 and 59). There is no good demarkation of these sub-ventral papillae into pre-anal and post-anal groups. The next to the last papilla in each of the sub-ventral rows is a large, double papilla. Including the two pairs anterior to this pair of double papillae as post-anal papillae, there is a total of seven pairs of post-anals, the anterior four pairs being part of the sub-ventral rows, the next two pairs being lateral in position, and the very small terminal pair being sub-ventral. The number of pairs of pre-anal papillae varies from 51 to 59. In addition there is a large unpaired median papilla at the anterior border of the cloacal opening. A short distance posterior to the cloacal opening is a median ventral cuticular plate, giving rise on either side to a series of about 5 or 6 sharp spines (Figs. 54, 55, and 56).

Tail of female 0.33 mm. long, terminating in a fine point (Fig. 61). Vulva relatively far forward, 5.24 mm. from anterior end. Vagina extends posteriorly 0.32 mm., forming one loop and joining single portion of uterus which continues posteriorly 1.1 mm. before dividing to form the two parallel uterine branches (Fig. 62). Ovaries extend to 1.79 mm. anterior to anus. Most eggs sub-spherical, with diameters from 37 to 41 μ. Some tended to be more or less oval, and one of these measured 44 by 33 μ. Ova within eggs apparently undivided (Fig. 63).

Discussion:

The genus *Terranova* Leiper and Atkinson, 1914 was considered a synonym of *Porrocaecum* Railliet and Henry, 1912 by Baylis in 1920. By 1945 *Porrocaecum* contained 41 species, of which 21 were from birds, 7 (5 larval) from mammals, 3

from reptiles, 5 from teleost fishes, and 5 from elasmobranchs. In that year Johnston and Mawson resurrected the genus *Terranova,* transferring to it all species of *Porrocaecum* lacking interlabia. This division of *Porrocaecum* proved to be correlated with the classification of the hosts. Thus the authors state that "all species from birds seem to possess interlabia" while those from marine mammals (2 species) and from fishes and elasmobranchs lack interlabia. No mention is made of the five species from land mammals, but in each case these have been described from larval forms encysted in the tissues of insectivore or rodent hosts, and, according to Walton (1927), the adult host of each is undoubtedly a bird of prey. There was also no reference to Chandler's (1935) two species from the cutlass fish, namely *Porrocaecum trichiuri* and *P. secundum.* These two species should be transferred to *Terranova,* forming the following new combinations:

Terranova trichiuri (Chandler, 1935) n. comb.

Synonym: *Porrocaecum trichiuri* Chandler, 1935
Host: *Trichiurus lepturus*

Terranova secundum (Chandler, 1935) n. comb.

Synonym: *Porrocaecum secundum* Chandler, 1935
Host: *Trichiurus lepturus*

The transfer of these two species raises to twelve the number of *Terranova* species from fish and elasmobranch hosts. Of these twelve, *T. nidifex* (Linton, 1900) Johnston and Mawson, 1945 and *T. trichiuri* (Chandler, 1935) are considered species inquirendae because of their inadequate descriptions. *T. trichiuri* and *T. secundum* were both originally described by Chandler from larval specimens which possessed no reproductive organs and were enclosed within sheaths in the mesenteries of their host, *Trichiurus lepturus,* taken from Galveston Bay, Texas. Lent and Freitas (1948) collected both species from this same host in Uruguay, including adults of *T. secundum,* both sexes of which they described completely. The specimens of *T. trichiuri,* however, were immature. Thus no description other than from immature forms exists for *T. trichiuri.* The description of *T. nidifex* is meager, but, as Johnston and Mawson (1945) have noted, the figures "suggest that it may belong to *Terranova*" and that it may even be identical with *T. galeocerdonis,* which is from the same host.

Comparisons:

Of the nine other valid species of *Terranova* from fishes and elasmobranchs, *T. ginglymostomae* differs from *T. draschei* (Stossich, 1896) Johnston and Mawson, 1945; *T. pristis* (Baylis and Daubney, 1922) Johnston and Mawson, 1945; *T. scoleodontis* (Baylis, 1931) Johnston and Mawson, 1945; and *T. cephaloscyllii* (Yamaguti, 1941) Johnston and Mawson, 1945 in either the presence of, or the arrangement of, the ventral post-cloacal spines of the male. It is unlike *T. antarctica* Leiper and Atkinson, 1914 in being a much more slender species, and it differs from *T. rochalimai* (Pereira, 1935) Johnston and Mawson, 1945 in that the caudal papillae of the male are more elongate and narrow. The presence of post-cloacal ventral spines was not mentioned in the description of the latter species and could not be determined from the figures; their absence would constitute an additional difference from

ginglymostomae. In *T. secundum* (Chandler, 1935) and *T. chiloscyllii* Johnston and Mawson, 1951 the esophageal ventriculus is much longer than in *T. ginglymostomae,* three to four times longer in the former and five to six times longer in the latter species. The remaining species, *T. galeocerdonis* (Thwaite, 1927) Johnston and Mawson, 1945 closely resembles *ginglymostomae* but differs in the presence of an additional pair of post-anal papillae in the male (the extra pair being adjacent and similar in size to the second pair from the posterior), and in the more posterior location of the vulva.

SPIRURIDAE Oerley, 1885

11. **Ascarophis sebastodis** new species

Plate IV, Figs. 64 to 67.

Host: Sebastodes caurinus (Richardson), copper rockfish
Location: Intestine
Locality: San Juan Island, Washington
Specific diagnosis: (Based on the single female specimen which was collected.)

Body extremely filiform, particularly in anterior half. Posteriorly, width of body increases very slowly, maximum width being attained at about 2/3 of body length from anterior end. This width maintained through most of remaining length of worm.

Length, 11.5 mm.; width at anterior end 0.013 mm., at anterior end of esophagus 0.03 mm., at posterior end of esophagus 0.07 mm., at vulva 0.11 mm.; maximum width 0.13 mm. Two small, lateral labial processes project anteriorly from the head. A stoma (vestibule) 0.10 mm. long and 0.011 mm. wide at its posterior end is present. Esophagus divided into anterior muscular portion, 0.39 mm. long and 0.015 mm. in maximum width, and long posterior glandular portion for which these measurements are 3.20 mm. and 0.031 mm. respectively. No cervical papillae detectable. Nerve ring wide, located 0.16 mm. from anterior end; excretory pore is 0.30 mm. from anterior end (Fig. 64). Tail relatively blunt, 0.074 mm. long (Fig. 65).

Vulva located 7.07 mm., about 3/5 of body length, from anterior end. Vagina extends posteriorly from vulva for 0.31 mm., its anterior half being modified as an ovejector, having thick, muscular walls (Fig. 66). Posteriorly the vagina joins the two uterine branches, which continue parallel for about 0.56 mm. where one branch bends anteriorly to form anterior genitalia. Anterior ovary extends to 2.97 mm. from anterior end, posterior ovary to 0.03 mm. from anus.

Eggs from uterus measure 35 to 40 μ by 20 to 22 μ. A few eggs were teased from the uterus, revealing the presence at one pole of a small knob from which extend two filaments varying from 33 to 210 μ in length. These filaments are not conspicuous when the eggs are observed in the uterus, but are only vaguely seen as a mass of fine threads winding about among the eggs. Since but one specimen was available, it was impossible to determine whether or not, as Cobb (1928) has suggested, the filaments increase in length as the developing eggs proceed along the uterus toward the vagina. Eggs near the vagina contain rather well differentiated larvae (Fig. 67).

Conspicuous spiral annulations mark the cuticula. Distance between these annulations diminishes anteriorly, and spirals are not in evidence at all anterior to nerve ring or posterior to anus. At posterior end of esophagus the spirals are 3.4 μ apart and at vulva 8.5 μ apart. Some anastomosing of spirals was seen, this being especially prevalent in the region from vulva anteriorly to posterior end of esophagus.

Comparisons:

The genus *Ascarophis* is at present made up of the following eleven species in addition to *A. sebastodis*, all from marine fish or elasmobranch hosts: *A. morrhuae* Beneden, 1871 (type species); *A. campbelli* (Chatin, 1885) Johnston and Mawson, 1943; *A. helix* Cobb, 1928; *A cestus* Chitwood, 1934; *A. acipenserina* (Dogiel, 1932) Chitwood, 1934; *A. australis* Johnston and Mawson, 1944; *A. upeneichthys* Johnston and Mawson, 1945; *A. nototheniae* Johnston and Mawson, 1945; *A. chalinurae* Johnston and Mawson, 1945; *A. lycodichthys* Johnston and Mawson, 1945; and *A. cooperi* Johnston and Mawson, 1945.

Due primarily to the great length of its posterior grandular part, the esophagus of *A. sebastodis* is considerably longer than that of any other species of the genus for which this measurement is given. The descriptions of *campbelli* and *lycodichthys* do not state the length of the esophagus. But the former species is unique in having "membranous expansions on either side of the mouth," and the mature females are over twice as long as those of *sebastodis*. Moreover, owing to the inadequate description of *A. campbelli*, its transfer to the genus *Ascarophis* by Johnston and Mawson (1943) is stated as being "provisional." *A. lycodichthys* is described from a single immature female only 4.6 mm. long and in such poor condition that almost no details of internal structure could be seen. However the length of the stoma is given as 0.16 mm., which is about four times as long in proportion to body length as in *A. sebastodis*.

Discussion:

There is considerable confusion at present as to the diagnosis of *Ascarophis*, and the correct systematic position of the genus is as yet open to question. One of the most striking characteristics of the type species, *A. morrhuae*, is the presence of conspicuous cuticular lines which form a continuous spiral about the worm, rather than the discrete annulations typical of nematodes generally. This characteristic, although not mentioned by van Beneden in his brief original description, was pointed out in redescriptions of this species by both Nicoll (1907) and Baylis (1933). In the meantime, Cobb (1928) had described the second species, *A. helix*, attaching considerable significance to the "helicoid development of the outer cuticle," and proposing the common name "screw-nemas" for the genus. Both Cobb and Baylis attribute the formation of the spirals to an anastomosis of ordinary annulations, but Baylis discounts their importance and states that the spiral nature of the cuticular annulations is "more apparent than real." Yet he includes the presence of "prominent annulations which tend to assume a spiral arrangement" in his diagnosis of the genus. Nevertheless, only three of the twelve species now in the genus, namely *A. morrhuae*, *A. helix*, and *A. sebastodis*, are described as definitely possessing spiral cuticular annulations.

CUCULLANIDAE Cobbold, 1864

12. **Cucullanus hansoni** new species

Plate V, Figs. 68 to 72.

Host: Balistes capistratus Shaw, trigger-fish

Location: Intestine

Locality: Honolulu, Hawaii

This species is named in honor of Miss Mary L. Hanson of the University of Nebraska, who, as previously stated. collected all the specimens from Hawaii dealt with in this study.

Of the five specimens of this species obtained, three were males and two females, one of each sex being immature. In the following description, measurements of both mature males are given, those of the smaller first; the measurements of the immature female follow in parentheses those of the mature female.

Specific diagnosis:

Length of males 3.49 to 5.00 mm.; of females 6.06 mm. (4.26 mm.). Maximum width of males 0.16 to 0.26 mm. (at about 1/3 of body length from the anterior); of females 0.36 mm. (0.21 mm.), at midbody.

Body abruptly truncated and inclined slightly dorsally at anterior end. Two lateral lips present, each bearing three papillae which are sub-dorsally, laterally, and sub-ventrally located, sub-dorsal and sub-ventral papillae prominent, laterals small and inconspicuous. At anterior edge of each lip is a narrow (8 μ) cuticular extension marked by longitudinal lines about 2.7 μ apart. Distance between the barely visible transverse cuticular annulations on the body varies from 2.7 to 3.4 μ.

Esophagus is of type characteristic of the genus, 0.43 to 0.51 mm. long in males and 0.58 mm. (0.49 mm.) long in females. Shortly anterior to the nerve ring the esophagus begins to dilate, forming the rather elongate false buccal capsule which comprises nearly half of the total esophageal length. Its inner walls bear a thick cuticular lining, and it attains a maximum width of 0.12 to 0.15 mm. in males and 0.14 mm. (0.106 mm.) in females. Esophagus narrowest at nerve ring, 0.06 to 0.067 mm. in males and 0.078 mm. (0.056 mm.) in females. Its posterior claviform portion attains width of 0.10 to 0.127 mm. in males and 0.13 mm. (0.104 mm.) in females. A short valvular apparatus projects from esophagus into intestinal lumen (Fig. 68). Distance from nerve ring to anterior end is 0.21 to 0.24 mm. in males and 0.27 mm. (0.24 mm.) in females. Cervical papillae are located at posterior end of esophagus, 0.52 mm. from the anterior end in the 5.00 mm. male. Excretory pore is 0.056 mm. posterior to esophagus in the 4.26 mm. immature female. Tail tapers gradually to a very fine point in both sexes, is 0.13 to 0.17 mm. long in males and 0.23 mm. (0.21 mm.) long in females.

Testis of males reaches to within 0.13 to 0.50 mm. from posterior end of esophagus. In the 3.49 mm. male it extends posteriorly for 1.31 mm., the vas deferens continuing for a distance of 1.01 mm. and opening into the cloaca through the ejaculatory duct, which is 0.20 mm. long. Spicules equal, 0.65 to 0.87 mm. long; gubernaculum, ellipsoidal-shaped in lateral view, measures 0.022 to 0.031 mm. Ventral sucker conspicuous, about 0.06 to 0.07 mm. long, its posterior edge being 0.31 to 0.45 mm. anterior to cloacal opening. Eleven pairs of caudal papillae present, three pre-anal, five more or less ad-anal, and three post-anal. The three pre-anals are much larger than the others, one located anterior and two posterior to the ventral sucker. Of the five ad-anals, four are sub-ventral and linear in arrangement, two anterior to and two posterior to the anus; the fifth is laterally located. Immediately posterior to this group of papillae the tail narrows abruptly, the post-anals being located on the narrow terminal portion which tapers gradually to a fine point. Of the three post-

anals, one pair is sub-dorsal, one lateral, and one sub-ventral, the latter being located slightly posterior to the other two (Figs. 69 and 70).

Vulva of female located well posterior to midbody, 3.51 mm. (2.55 mm.) from anterior end. Vagina extends anteriorly from vulva, its length and details of its connection with the uteri being obscure. Uteri divergent; anterior ovary extends to 0.53 mm. from posterior of esophagus, posterior ovary to 0.39 mm. from anus in the mature female. Lateral tail papillae are located 0.10 mm. (0.078 mm.), or less than half the tail length, from the anus (Fig. 71). Eggs in uterus thin-shelled, measuring 60 to 70 μ by 39 to 52 μ; some appeared to contain embryos in the 2-celled stage (Fig. 72).

Comparisons:

These worms show a slight inclination of the anterior end toward the dorsal surface, as shown in Fig. 68. Since this trait is one of the diagnostic features of the genus *Dacnitis*, it was initially supposed that this species properly belonged in that genus rather than in *Cucullanus*. Further observations revealed that *hansoni* possesses none of the other important characteristics of *Dacnitis*, as defined by Törnquist (1931), among which are the presence of a more or less distinct dorsal thickening of the body wall just posterior to the anterior end; a roundish mouth cavity (false buccal capsule) formed by an abrupt widening of the esophagus, the latter remaining uniform in width for a considerable distance anterior to the nerve ring; and the occurrence in the female of a rounded tail tip, bearing a small cuticular spine. These discrepancies with *Dacnitis* made it apparent that this species is closer to *Cucullanus*.

C. hansoni is distinguishable from most other species in the genus *Cucullanus* by its small size, *C. micropapillatus* being the only species of considerably smaller size. Those species of the genus whose size range approximates that of *C. hansoni* are *C. parvus*, *C. zungaro*, *C. mogi*, *C. pinnai*, and *C. lophilatilus*. In none of these except *C. Parvus* Törnquist, 1931 do the proportions of various structures agree with those in *hansoni*. However, a distinction between these two species is to be found in the arrangement of the male caudal papillae. *C. parvus* has four pairs of papillae in the group near the anus, three of which are sub-ventral and in linear sequence, the fourth being lateral. In *C. hansoni* this same group consists of five pairs of papillae, an additional pair being present in the sub-ventral linear row. In addition, the tail of the male of *hansoni* is considerably more slender than in *parvus*.

13. **Cucullanus longipapillatus** new species

Plate V, Figs. 73 to 78.

Hosts: Melichthys buniva (Lacépède), trigger-fish, type host; *Balistes vidua* Richardton, trigger-fish

Location: Intestine

Locality: Honolulu, Hawaii

Specific diagnosis: (Measurements are based on 3 mature males and 4 mature females).

Length of males 11.1 to 14.1 mm.; maximum width, at about mid-body, 0.32 to 0.49 mm. Length of females 13.8 to 16.6 mm.; maximum width, at about mid-body,

0.32 to 0.60 mm. Body width in both sexes relatively uniform through middle ¾ of body length.

The mouth opening is elongated dorso-ventrally. In *en face* view, a pair of tooth-like structures may be seen projecting medially from each lateral margin of the mouth opening. Three pairs of cephalic papillae present, one sub-dorsal, one lateral, and one sub-ventral. Laterals are small and inconspicuous, but remaining four papillae have long peduncles projecting about 18 μ from surface of head, forming one of the most distinctive features of the species. Anterior dilated portion of the esophagus, the "false buccal capsule," possesses a thickly cuticularized inner lining (Figs. 73 and 75).

Esophagus of males 0.71 to 0.75 mm. long. Its anterior expanded portion attains maximum width of 0.082 to 0.093 mm., and width of posterior portion is 0.104 to 0.123 mm. Minimum width of esophagus, at level of nerve ring, is 0.041 to 0.056 mm. Nerve ring and cervical papillae 0.17 to 0.18 mm. and 0.45 to 0.55 mm. from anterior end respectively. Excretory pore of 14.1 mm. male was 0.65 mm. from anterior end. Esophagus of females 0.76 to 0.84 mm. long; maximum widths of its anterior and posterior expanded portions are 0.082 to 0.093 mm. and 0.112 to 0.130 mm. respectively. Minimum width of esophagus, at level of nerve ring, is 0.041 to 0.052 mm. Distances from anterior end to nerve ring and cervical papillae are 0.17 to 0.20 mm. and 0.58 to 0.64 mm. respectively. Excretory pore of 16.6 mm. female is 0.64 mm. from anterior end. In both sexes a short valvular apparatus projects from esophagus into intestine (Fig. 74). Distance between cuticular annulations ranges from 2 to 3 μ.

Testis of males reaches to within 1.07 to 5.08 mm. from posterior of esophagus. Ejaculatory duct varies in length from 0.54 to 0.71 mm. The equal spicules are 2.24 to 2.82 mm. long, the gubernaculum 0.09 to 0.10 mm. in length. Distance from posterior of ventral sucker to cloacal opening ranges from 1.01 to 1.42 mm. Ten pairs of caudal papillae present, 6 pairs pre-anal, 2 ad-anal, and 2 post-anal. Anteriormost 3 pairs of pre-anals are sub-ventrally located and larger than the others, the first being just anterior to sucker, and the second and third in linear sequence posterior to sucker. Remaining 3 pairs of pre-anals located in a group shortly anterior to cloacal opening, two sub-ventrally and one laterally situated. Of the two sub-ventral pairs of ad-anal papillae, one pair is located at level of cloacal opening and the other pair slightly posterior at angle formed between narrow tail and protuberance surrounding cloacal opening. The two pairs of post-anals are located at about 1/3 and 2/3 of tail length respectively from cloacal opening, the anterior pair being lateral and the posterior pair sub-ventral in position. Tail ends in a fine point and measures 0.21 to 0.26 mm. in length (Fig. 76).

Vulva of female located slightly posterior to mid-body, 8.4 to 10.5 mm. from anterior end. From it a narrow muscular vagina extends anteriorly 0.85 to 1.14 mm., there joining the two divergent uteri. In the 16.6 mm. female, anterior and posterior uteri measure 1.49 and 1.65 mm. respectively, and each is continuous with a narrowed oviduct which bends back and extends in the opposite direction to join ovary from other end of worm. Thus the posterior uterus receives eggs from ovary at anterior end. Anterior ovary reaches to within 1.18 to 1.45 mm. from posterior of esophagus, posterior ovary to within 0.52 to 0.98 mm. from anus. Eggs in uteri contain segmenting embryos and measure 65 to 71 μ long and 34 to 40 μ wide (Fig. 78). In some specimens the eggs were apparently unfertilized, containing a homogeneous granular

mass which nearly filled the space within the shell. Larger measurements were recorded for these eggs, lengths ranging up to 82 μ and widths to 50 μ. Rectum 0.18 to 0.21 mm. long, tail 0.32 to 0.40 mm. long. Small, lateral tail papillae located 0.12 to 0.14 mm. from anus (Fig. 77).

Comparisons:

Cucullanus longipapillatus may be readily distinguished from all of the approximately 30 other species of *Cucullanus* from fish hosts by the elongated condition of the sub-dorsal and sub-ventral pairs of the cephalic papillae. Though by no means all of the descriptions of species in the genus furnish a figure of the anterior end, it may be safely assumed, in the writer's opinion, that had similarly elongated cephalic papillae been present in any of these species either they would have been figured or specific mention of their presence made in the written description.

Another unusual characteristic of *longipapillatus* is the shortness of the esophagus in relation to body size. The only species in which the relative length of the esophagus is not substantially greater than in *longipapillatus* are *C. antipodeus* Baylis, 1932; *C. elongatus* Smedley, 1933; *C. filiformis* Yamaguti, 1935; and *C. pinnai* Travassos, Artegas, and Pereira, 1928. In each of these four species, however, the spicules are much shorter, both absolutely and relatively, than in *longipapillatus*. In fact, the only species in which the absolute length of the spicules is recorded as exceeding that of *longipapillatus* is *C. heterodonti* Johnston and Mawson, 1943, which has spicules 3.2 mm. long

14. **Cucullanus robustus** Yamaguti, 1935

Host: Leptocephalus conger Linnaeus, conger eel

Location: Intestine

Locality: Wellington, New Zeland

This is apparently the first time this species has been reported from any host other than the type host, *Conger myriaster*, another marine eel taken from the Inland Sea and Ise Bay, Japan.

CAMALLANIDAE Railliet and Henry, 1915

At the present time the family Camallanidae is made up of the four genera *Camallanus* Railliet and Henry, 1951; *Camallanides* Baylis and Daubney, 1922; *Procamallanus* Baylis, 1923; and *Paracamallanus* Yorke and Maplestone, 1926. These four genera are distinguished from one another primarily by variations in structure of the buccal capsule. The third genus to be named, *Procamallanus*, differs from the other three in that the buccal capsule lacks lateral valves resembling "clam-shells," having instead a continuous wall. Also the dorsal and ventral trident-shaped processes, which serve as attachments for muscles operating the lateral valves of the buccal capsule in *Camallanus*, are lacking in *Procamallanus*. In Baylis' opinion *Procamallanus* approaches the primitive form from which other camallanid species, with their complex mouthparts, were probably derived.

To date, a total of twenty-four species have been named in the genus, of which three are from amphibians and the remaining twenty-one from marine or fresh-water fishes. Eight species possess a smooth buccal capsule lining; in the remaining sixteen

species the buccal capsule lining shows spiral thickenings. Two species have but one spicule, the rest two spicules (in *P. kerri* the male is unknown). Yamaguti (1935) and Annereaux (1946) have suggested the desirability of dividing the genus on the basis of the presence of one or two spicules. There is, however, some reason for believing that the two species (*P. parasiluri* Fujita, 1927 and *P. slomei* Southwell and Kirshner, 1937) in which but one spicule has been noted may have been erroneously described. Kung (1948) states, in describing *P. brevis,* that the left spicule was "so poorly chitinized and slender that it is easily overlooked" and adds that "it appears possible that the left spicule of *P. slomei* may have been overlooked." Yamaguti (1935), who added the description of the male to Fujita's original description of the female of *P. parasiluri,* states that his specimens were immature and admits the possibility that a second spicule may have been visible in mature males. In view of these circumstances the writer is of the opinion that the nature of the inner lining of the buccal capsule represents a more valid basis for dividing the genus than does spicule number. This view also gains support from the fact that buccal capsule structure is the main criterion by which the other genera within the family are distinguished. Accordingly, it is proposed that the generic name *Procamallanus* be restricted to those species with a smooth buccal capsule lining, as is found in the type species, *P. laeviconchus*. For the remaining species in the original genus, those in which the buccal capsule lining bears spiral thickenings, the generic name *Spirocamallanus* n. gen. is proposed.

Procamallanus sensu stricto

Generic diagnosis:

Camallanidae. Buccal capsule continuous, not separated into paired lateral valves; inner lining of capsule smooth. Esophagus divided into anterior muscular and posterior glandular portions, the latter usually being the longer. Caudal alae present in males; up to 18 pairs of caudal papillae present. Gubernaculum absent. Two spicules present, equal or unequal. Tip of tail of female blunt, may bear a number of spinous processes. Vulva located in middle third of body. Viviparous. Parasites of fishes and amphibians. Type species: *Procamallanus laeviconchus* (Wedl, 1862) Baylis, 1923. Hosts: *Synodontis schaal* and *Bagrus bayad.*

Other species of *Procamallanus*

2. *P. mehrii* Agarwal, 1930
   Host: *Wallago attu*
3. *P. sphaeroconchus* Törnquist, 1931
   Hosts: *Serranus* sp.
   Teuthis sp.
4. *P. planoratus* Kulkarni, 1935
   Host: *Clarias batrachus*
5. *P. sigani* Yamaguti, 1935
   Host: *Siganus fuscescens*
6. *P. slomei* Southwell and Kirshner, 1937
   Host: *Xenopus laevis*

7. *P. lonis* Yamaguti, 1941
   Host: *Lo unimaculatus*
8. *P. brevis* Kung, 1948
   Host: "Bullfrog," South Africa

Spirocamallanus new genus

Generic diagnosis:

Camallanidae. Buccal capsule continuous, not separated into paired lateral valves; inner wall of capsule bears spiral thickenings, either continuous or consisting of interrupted streaks. Esophagus divided into anterior muscular and posterior glandular portions, the latter usually being longer. Caudal alae present in males; up to 14 pairs of caudal papillae present. Gubernaculum absent. Two spicules present, equal or unequal, similar or dissimilar in shape. Tail of female may or may not bear a number of spinous processes. Vulva located in the posterior two-thirds of the body. Viviparous. Parasites of fishes and amphibians. Type species: *Spirocamallanus spiralis* (Baylis, 1923) n. comb.; Synonym: *Procamallanus spiralis* Baylis, 1923; Hosts: *Heterobranchus anguillaris* and *Synodontis eupterus.*

Other species of *Spirocamallanus*

2. *Spirocamallanus parasiluri* (Fujita, 1927) n. comb.
   Synonym: *Procamallanus parasiluri* Fujita, 1927
   Host: *Parasilurus asotus*
3. *Spirocamallanus inopinatus* (Travassos, Artegas, and Pereira, 1928) n. comb.
   Synonym: *Procamallanus inopinatus* Travassos, Artegas and Pereira, 1928
   Host: *Leporinus* sp.
4. *Spirocamallanus iheringi* (Travassos, Artegas, and Pereira, 1928) n. comb.
   Synonym: *Procamallanus iheringi* Travassos, Artegas, and Pereira, 1928
   Hosts: *Salminus hilarii, Leporinus* sp., *Hoplias* sp., *Tetragonopterus* sp., and *Anostomatinae* sp.
5. *Spirocamallanus rarus* (Travassos, Artegas, and Pereira, 1928) n. comb.
   Synonym: *Procamallanus rarus* Travassos, Artegas, and Pereira, 1928
   Hosts: *Pimelodella lateristriga* and *Rhynodoras dorbignyi*
6. *Spirocamallanus xenopodis* (Baylis, 1929) n. comb.
   Synonym: *Procamallanus xenopodis* Baylis, 1929
   Host: *Xenopus mülleri*
7. *Spirocamallanus kerri* (Pearse, 1933) n. comb.
   Synonym: *Procamallanus kerri* Pearse, 1933
   Host: *Glossobobius giurus*
8. *Spirocamallanus amarali* (Vaz and Pereira, 1934) n. comb.
   Synonym: *Procamallanus amarali* Vaz and Pereira, 1934
   Host: *Leporinus* sp.
9. *Spirocamallanus hilarii* (Vaz and Pereira, 1934) n. comb.
   Synonym: *Procamallanus hilarii* Vaz and Pereira, 1934
   Host: *Salminus hilarii*
10. *Spirocamallanus barroslimai* (Pereira, 1935) n. comb.
    Synonym: *Procamallanus barroslimai* Pereira, 1935
    Host: "Sardinha"

11. *Spirocamallanus fariasi* (Pereira, 1935) n. comb.
    Synonym: *Procamallanus fariasi* Pereira, 1935
    Hosts: *Leporinus* sp., *Pygocentrus* sp., and "Cangati"
12. *Spirocamallanus wrighti* (Pereira, 1935) n. comb.
    Synonym: *Procamallanus wrighti* Pereira, 1935
    Hosts: *Hoplias malabaricus, Leporinus* sp., *Astyanax* sp., and *Pygocentrus* sp.
13. *Spirocamallanus fulvidraconis* (Li, 1935) n. comb.
    Synonym: *Procamallanus fulvidraconis* Li, 1935
    Host: *Pseudobagrus fulvidraco*
14. *Spirocamallanus cearensis* (Pereira, Vianna, and Azevedo, 1936) n. comb.
    Synonym: *Procamallanus cearensis* Pereira, Vianna, and Azevedo, 1936
    Host: *Astyanax bimaculatus vittatus*
15. *Spirocamallanus murrayensis* (Johnston and Mawson, 1940) n. comb.
    Synonym: *Procamallanus murrayensis* Johnston and Mawson, 1940
    Hosts: *Pseudaphritis urvillei, Percalates colonorum,* and *Plectroplites ambiguus.*
16. *Spirocamallanus pereirai* (Annereaux, 1946) n. comb.
    Synonym: *Procamallanus pereirai* Annereaux, 1946
    Host: *Atherinopsis californiensis*
17. *Spirocamallanus monotaxis* new species

Plate V, Figs. 79 to 84.

Host: Monotaxis grandoculis (Forskal), porgy

Location: Intestine

Locality: Honolulu, Hawaii

Specific diagnosis: (Measurements are based on one mature female and two mature male specimens).

Brownish in appearance when preserved in alcohol. Female 34.0 mm. long and 0.55 mm. in maximum width; males 15.8 to 17.7 mm. long and 0.26 to 0.29 mm. in maximum width. Males sharply curved ventrally at posterior end. In both sexes the anterior end appears smoothly rounded with no papillae in evidence. Fine, transverse cuticular striations present, 3.7 to 4.0 μ apart.

Barrel-shaped buccal capsule 0.11 mm. long and 0.08 mm. wide in the female, 0.11 mm. long and 0.07 mm. wide in the male. Its rather refractile cuticular lining is formed into a series of continuous spiral thickenings, numbering 16 in the male but only 10 in the female. A ring-shaped thickening is present at base of buccal capsule (Fig. 79). Anterior claviform muscular portion of esophagus 0.59 mm. long and 0.12 mm. in maximum width in the female, 0.39 to 0.44 mm. long and 0.08 to 0.09 mm. in maximum width in the male. Nerve ring located at narrowest point of esophagus, 0.37 mm. from anterior end in the female and 0.28 to 0.30 mm. from anterior end in the male. Excretory pore situated a short distance anterior to junction of muscular and glandular portions of esophagus, 0.19 mm. posterior to nerve ring in the male 15.8 mm. long. Posterior glandular portion of esophagus, also claviform, 1.11 mm. long and 0.13 mm. in maximum width in the female, 0.63 to 0.76 mm. long and 0.11 to 0.12 mm. in maximum width in the male. A short valvular apparatus

projects from glandular portion of esophagus into intestine (Fig. 80). Intestine relatively narrow throughout its length, never exceeding 0.12 mm. in width in the female or 0.08 mm. in width in the male.

Distance from anterior end of female to vulva is 13.6 mm., or slightly more than three-eights of body length. Vagina directed posteriorly from vulva, its distal portion consisting of a short (0.07 mm.) thin-walled neck adjacent to the vulva followed by an expanded muscular structure, about 0.72 mm. long (Fig. 84). The vagina then continues posteriorly as a narrow tube which could be traced back to a point 3.9 mm. from vulva. Its point of connection with the uterus could not be determined with certainty since the large uterus, which occupies most of the body cavity, is so filled with developing eggs or larval worms as to obscure details of other structures. Apparently the vagina communicates with two divergent uterine branches, the anterior of which leads to an ovary a short distance posterior to the esophagus. This ovary extends back posteriorly to about the level of the vulva. The posterior branch of the uterus appears to end blindly. Larvae in uterus are about 0.34 mm. long and 0.018 mm. wide.

Rectum of female 0.31 mm. long; anus located 0.24 mm. from posterior end. Numerous conspicuous muscle strands extend across body cavity in region of anus. Tail terminates in a small conical tip, 0.04 mm. long, at extremity of which are two extremely minute papilla-like projections, apparent only under high magnification (Fig. 83).

Testis of 17.7 mm. male begins 1.46 mm. from anterior end and extends posteriorly for 7.0 mm. There, at a constriction, it opens into the seminal vesicle, which continues posteriorly for 7.1 mm. At another constriction at the posterior end of the seminal vesicle, the ejaculatory duct arises, extending 1.7 mm. to the cloaca. Anus located 0.20 mm. from posterior end. Caudal alae extend anteriorly 0.67 mm., where they converge and are continuous across ventral surface. Seven pairs of pedunculate caudal papillae present, 3 pairs pre-anal, 1 pair ad-anal, and 3 pairs post-anal. Spicules similarly shaped but unequal in size; right spicule 0.29 to 0.32 mm. long, left spicule 0.23 to 0.24 mm. long (Figs. 81 and 82).

Comparisons:

Since *Spirocamallanus monotaxis* has two similarly shaped spicules of unequal size and a buccal capsule in which the number of spiral thickenings is greater than eight in both sexes, it is most closely allied to the species *S. amarali* (Vaz and Pereira, 1934) and *S. pereirai* (Annereaux, 1946). It differs from each of these species in that the male has fewer caudal papillae, the right spicule of the male is considerably shorter, and the total body length of both sexes is much greater, 2½ to 4 times as great as in *S. pereirai* and over 1½ times as great as in *S. amarali.* Also, the number of spiral thickenings lining the buccal capsule of *S. pereirai* is 14 in both sexes and the male of *S. amarali* possesses 8 (only the male is known), whereas in my specimens there are 16 in the male and only 10 in the female, this being the only instance in the genus in which the number in the male is described as exceeding that in the female. In other species either the reverse is true or the number is equal in the two sexes. It should be noted, however, that in four species only one of the sexes is known, and in the descriptions of four additional species, no mention is made of the number of these thickenings.

SUMMARY

1. Fifteen species of nematodes are reported from sixteen marine fishes. Nematode families represented are Ascaridae (Stomachinae), Spiruridae, Cucullanidae, and Camallanidae.

2. The new genus *Spirocamallanus* is erected to contain sixteen species transferred from the genus *Procamallanus* and one new species.

3. The following ten new species are described:

Contracaecum melichthysi
Host: *Melichthys buniva* (Lacépède), trigger-fish
Contracaecum ogcocephali
Host: *Ogcocephalus radiatus* (Mitchill), bat-fish
Contracaecum chaunaxi
Host: *Chaunax* sp.
Heterotyphlum eurycheilum
Host: *Promicrops itaiara* (Lichtenstein), jew-fish
Raphidascaris lutiani
Host: *Lutianus analis* (Cuvier and Valenciennes), muttonfish
Terranova ginglymostomae
Host: *Ginglymostoma cirratum* (Gmelin), nurse shark
Ascarophis sebastodis
Host: *Sebastodes caurinus* (Richardson), copper rock-fish
Cucullanus hansoni
Host: *Balistes capistratus* Shaw, trigger-fish
Cucullanus longipapillatus
Hosts: *Melichthys buniva* (Lacépède), trigger-fish
Balistes vidua Richardson, trigger-fish
Spirocamallanus monotaxis
Host: *Monotaxis grandoculis* (Forskal), porgy

4. In addition to the sixteen species transferred from *Procamallanus* to the new genus *Spirocamallanus,* the following three new combinations are formed:
Raphidascaroides diodonis (Thwaite, 1927)
Synonym: *Raphidascaris diodonis* Thwaite, 1927
Terranova trichiuri (Chandler, 1935)
Synonym: *Porrocaecum trichiuri* Chandler, 1935
Terranova secundum (Chandler, 1935)
Synonym: *Porrocaecum secundum* Chandler, 1935

5. *Contracaecum histiophori* Yamaguti, 1935 is redescribed, the first description of mature males being given.

6. The following four species are recorded from new hosts:
Contracaecum histiophori Yamaguti, 1935
Contracaecum aduncum (Rudolphi, 1802) Baylis, 1923
Raphidascaroides nipponensis Yamaguti, 1941
Cucullanus robustus Yamaguti, 1935

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EXPLANATION OF PLATES

All figures were drawn with the aid of a camera lucida. The value of the projected scale is indicated in millimeters in each figure.

The following abbreviations are used:

cm copulatory muscles
cp caudal papilla
cvp cervical papilla
ed ejaculatory duct
g gubernaculum
i intestine
pvp postanal ventral plate
sp spicule
st stoma
tp tail papilla

Plate I

Contracaecum melichthysi

Host: *Melichthys buniva* (Lacépède)

Locality: Hawaii

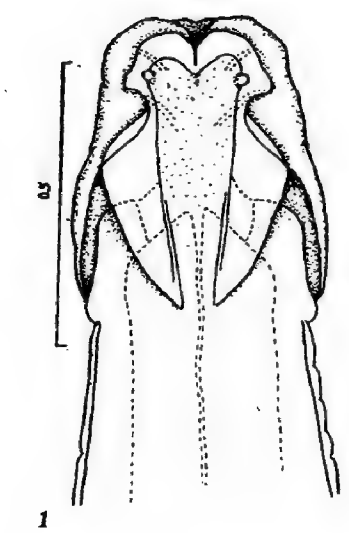
Fig. 1. Anterior end, dorsal view.
Fig. 2. Anterior end, ventral view.
Fig. 3. Right sub-ventral lip.
Fig. 4. Anterior end, *en face* view.
Fig. 5. Posterior end of esophagus, showing ventriculus, esophageal appendix, and intestinal cecum.
Fig. 6. Posterior end of male, lateral view.
Fig. 7. Distal tip of spicule.
Fig. 8. Tip of tail of male, lateral view.
Fig. 9. Region of vulva of female.
Fig. 10. Posterior end of female, lateral view.
Fig. 11. Egg.

Contracaecum ogcocephali

Host: *Ogcocephalus radiatus* (Mitchill)

Locality: Tortugas, Florida

Fig. 12. Anterior end, lateral view.
Fig. 13. Anterior end, dorsal view.
Fig. 14. Posterior end of esophagus, showing ventriculus, esophageal appendix, and intestinal cecum.
Fig. 15. Posterior end of male, lateral view.
Fig. 16. Posterior end of female, lateral view.
Fig. 17. Egg.



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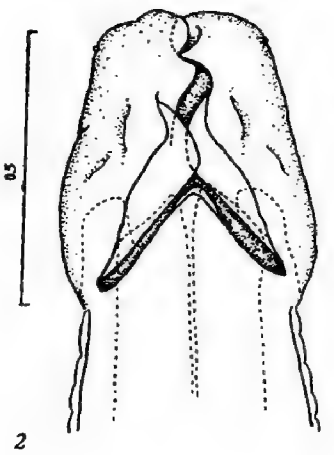

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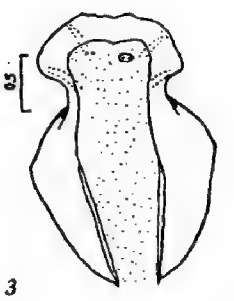

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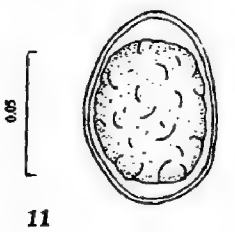

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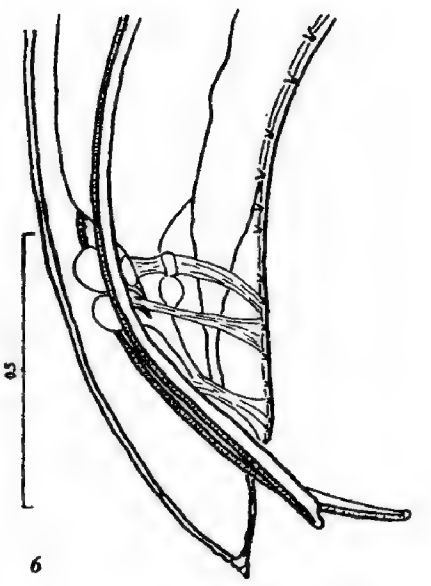

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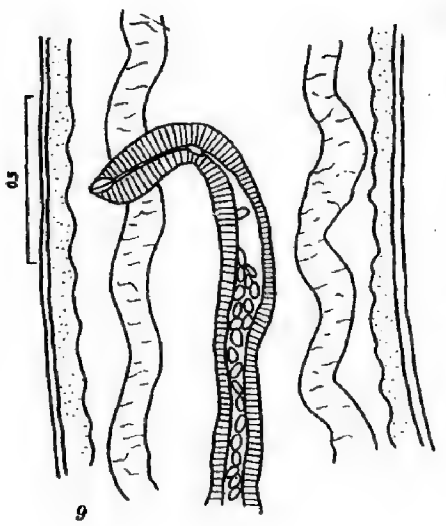

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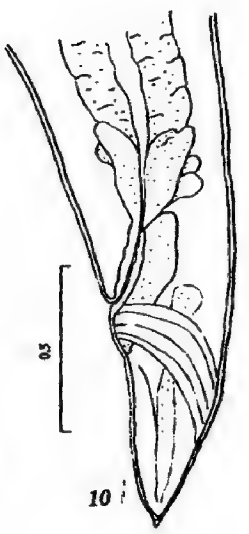

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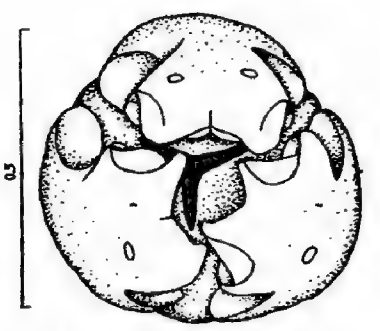

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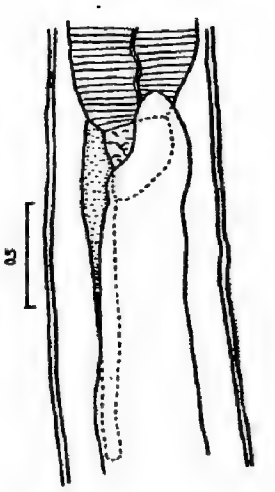

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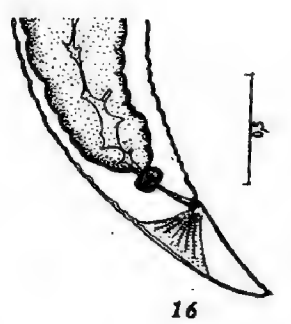

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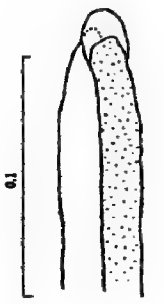

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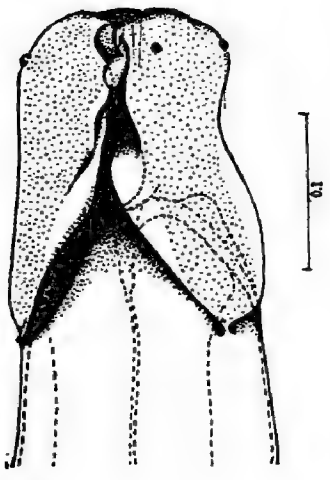

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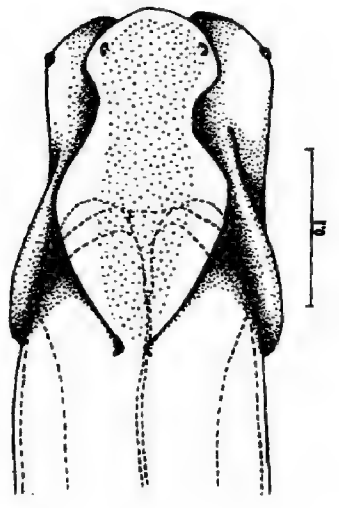

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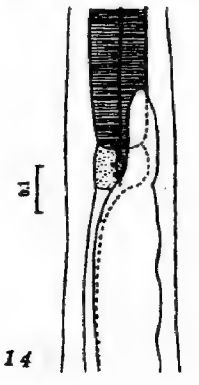

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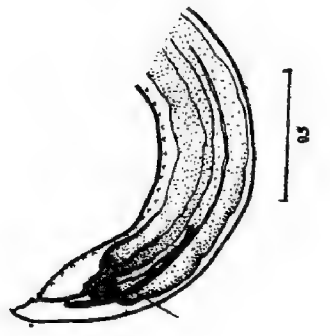

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Plate II

Contracaecum chaunaxi

Host: *Chaunax* sp.

Locality: Tortugas, Florida

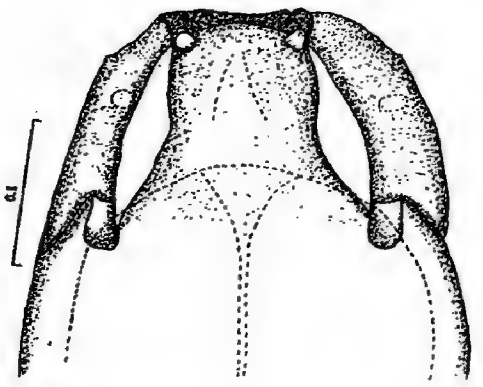
Fig. 18. Anterior end, dorsal view.
Fig. 19. Anterior end, ventral view.
Fig. 20. Left sub-ventral lip.
Fig. 21. Posterior end of esophagus, showing ventriculus, esophageal appendix, and intestinal cecum.
Fig. 22. Posterior end of male, lateral view.

Contracaecum histiophori

Host: *Istiophorus americanus* Cuvier and Valenciennes

Locality: Florida

Fig. 23. Anterior end, dorsal view.
Fig. 24. Anterior end, ventral view.
Fig. 25. Right sub-ventral lip.
Fig. 26. Anterior end, *en face* view.
Fig. 27. Posterior end of male, lateral view.
Fig. 28. Cuticular crests on posterior ventral surface of male.
Fig. 29. Distal tip of spicule.
Fig. 30. Region of vulva of female.



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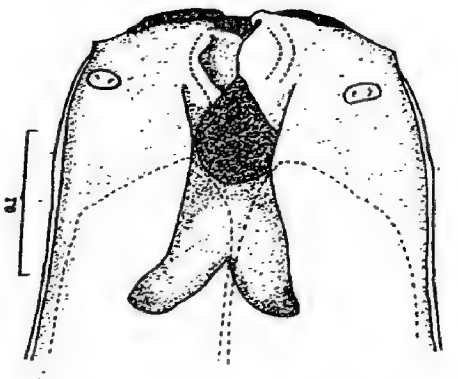

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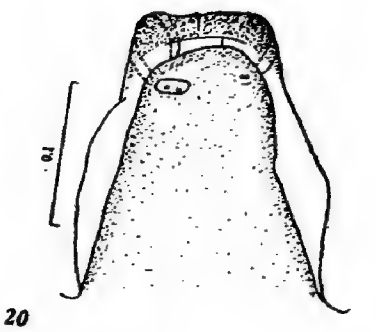

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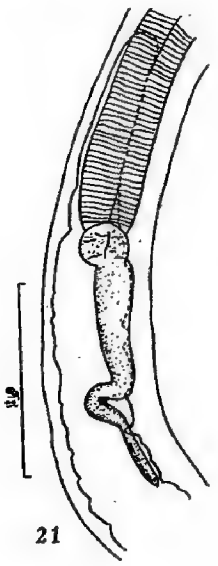

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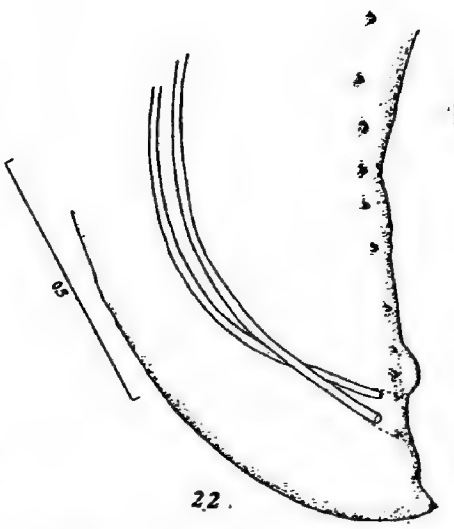

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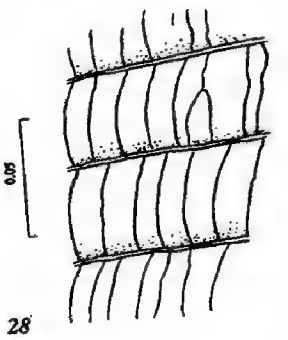

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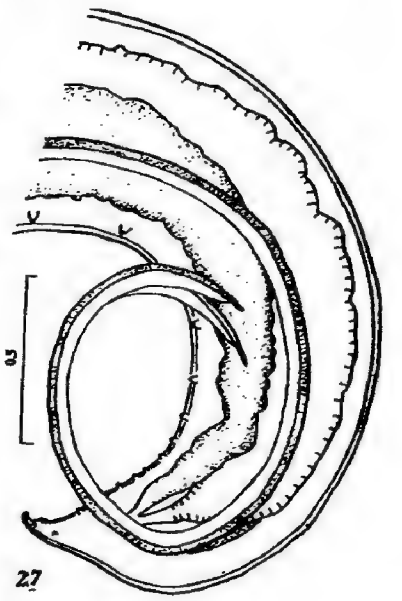

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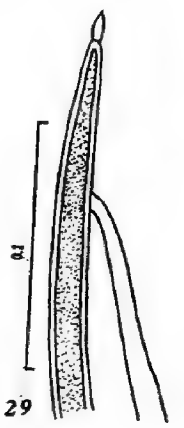

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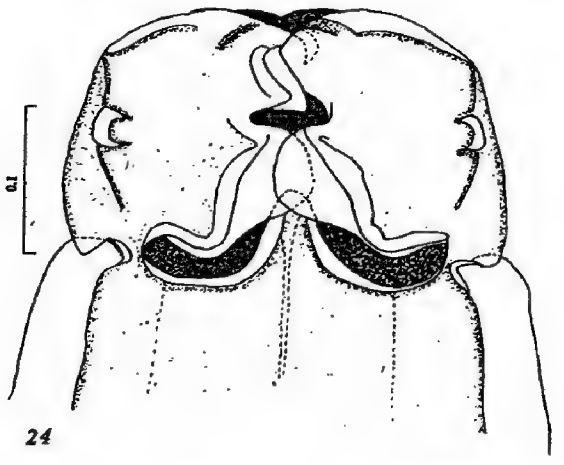

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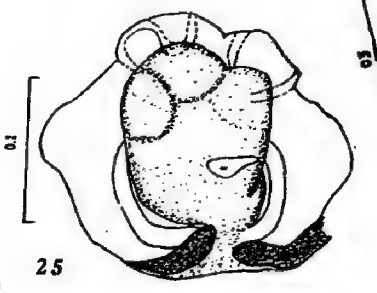

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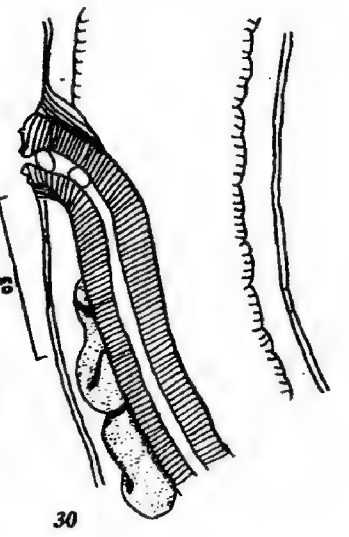

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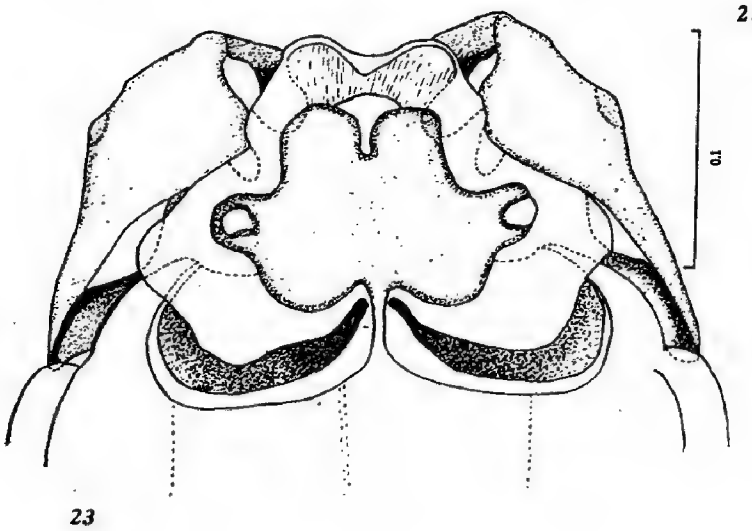

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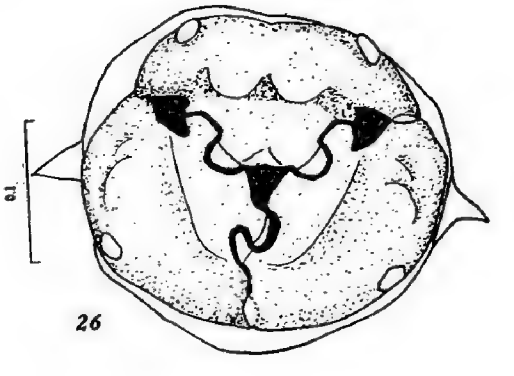


26

Plate III

Contracaecum histiophori (continued)

Host: *Istiophorus americanus* Cuvier and Valenciennes

Locality: Florida

Fig. 31. Egg.
Fig. 32. Posterior end of female, lateral view.

Heterotyphlum eurycheilum

Host: *Promicrops itaiara* (Lichtenstein)

Locality: Tortugas, Florida

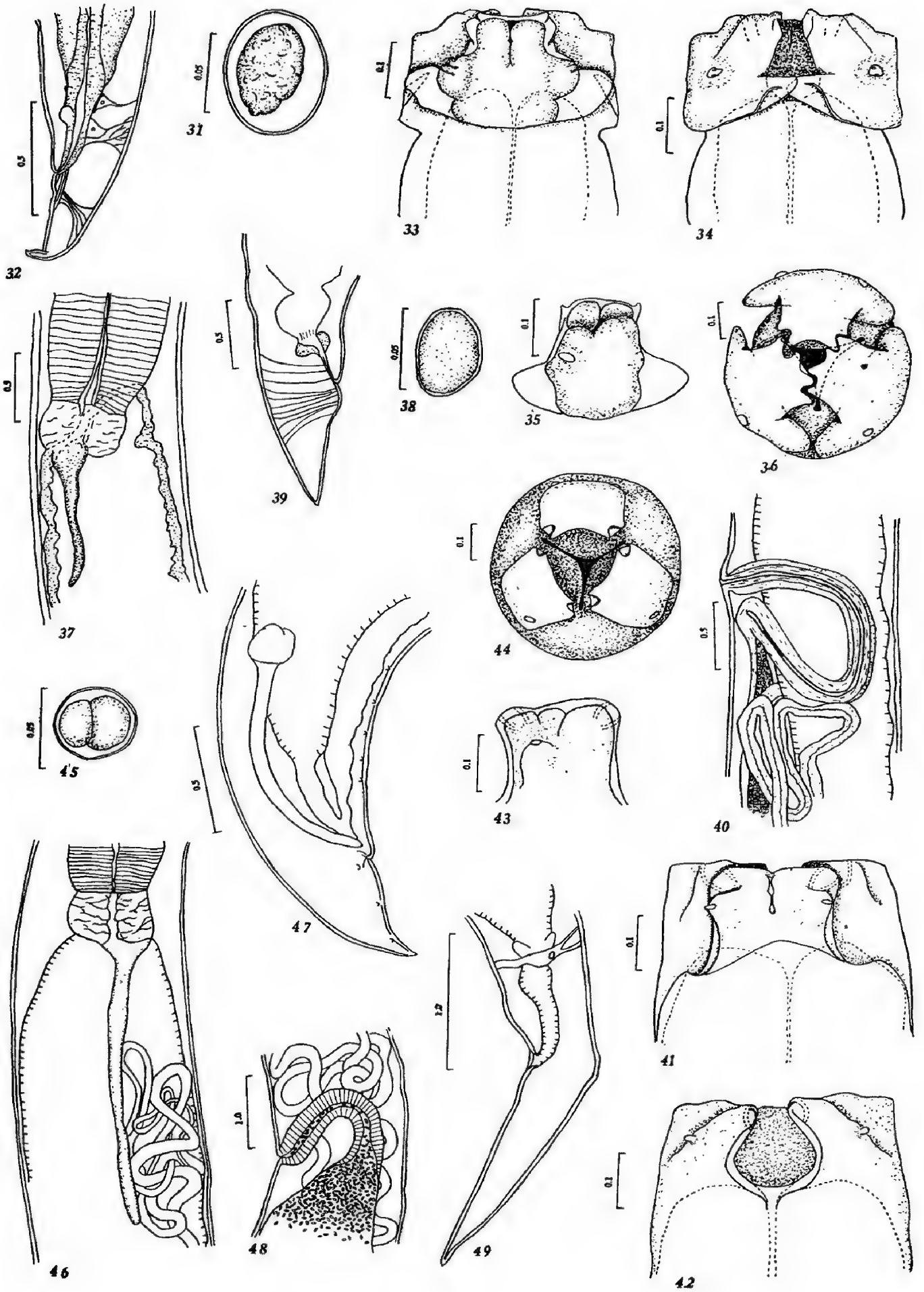
Fig. 33. Anterior end, dorsal view.
Fig. 34. Anterior end, ventral view.
Fig. 35. Left sub-ventral lip.
Fig. 36. Anterior end, *en face* view.
Fig. 37. Posterior end of esophagus, showing ventriculus, esophageal appendix, and intestinal cecum.
Fig. 38. Egg.
Fig. 39. Posterior end of female, lateral view.
Fig. 40. Region of vulva of female.

Raphidascaris lutiani

Host: *Lutianus analis* (Cuvier and Valenciennes)

Locality: Tortugas, Florida

Fig. 41. Anterior end, dorsal view.
Fig. 42. Anterior end, ventral view.
Fig. 43. Left sub-ventral lip.
Fig. 44. Anterior end, *en face* view.
Fig. 45. Egg.
Fig. 46. Posterior end of esophagus, showing ventriculus and esophageal appendix
Fig. 47. Posterior end of male, lateral view.
Fig. 48. Region of vulva of female.
Fig. 49. Posterior end of female, lateral view.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0.1
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43
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46
1.0
48
1.2
49
0.1
41
0.1
42

Plate IV

Terranova ginglymostomae

Host: *Ginglymostoma cirratum* (Gmelin)

Locality: Tortugas, Florida

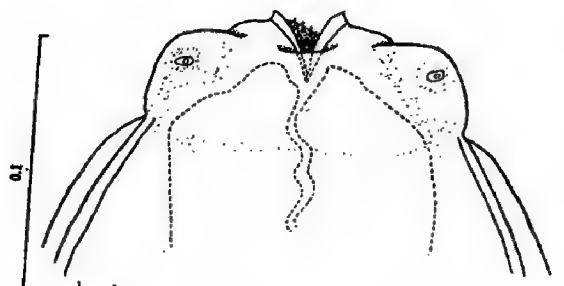
Fig. 50. Anterior end, ventral view.
Fig. 51. Anterior end, dorsal view.
Fig. 52. Posterior end of esophagus, showing ventriculus and intestinal cecum.
Fig. 53. Cervical papilla.
Fig. 54. Posterior end of male, lateral view, showing dorsal curvature.
Fig. 55. Posterior end of male, ventral view.
Fig. 56. Posterior end of male, lateral view.
Fig. 57. Lateral view showing appearance of caudal papillae of male.
Fig. 58. Distal tip of spicule.
Fig. 59. Transverse section of posterior end of male in region of ejaculatory duct, anterior to spicules.
Fig. 60. Transverse section of posterior end of male in region of spicules.
Fig. 61. Posterior end of female, lateral view.
Fig. 62. Region of vulva of female.
Fig. 63. Egg.

Ascarophis sebastodis

Host: *Sebastodes caurinus* (Richardson)

Locality: San Juan Island, Washington

Fig. 64. Anterior end, ventral view.
Fig. 65. Posterior end of female, lateral view.
Fig. 66. Region of vulva of female.
Fig. 67. Egg, showing polar knob and filaments.



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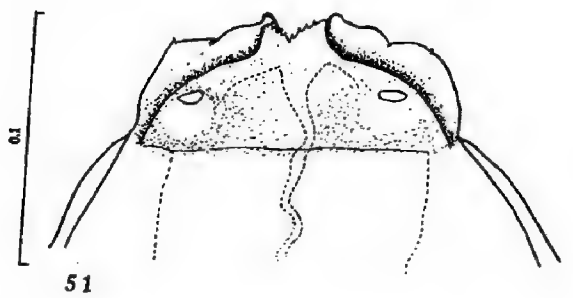

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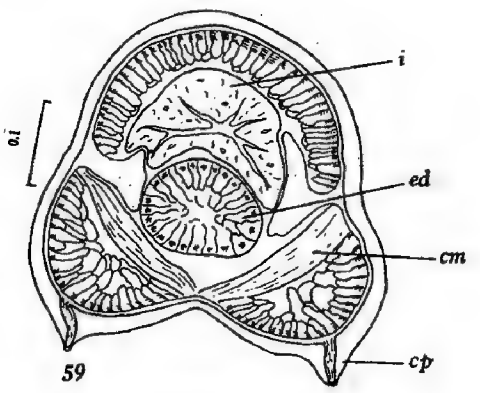

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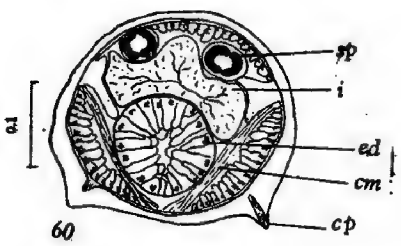

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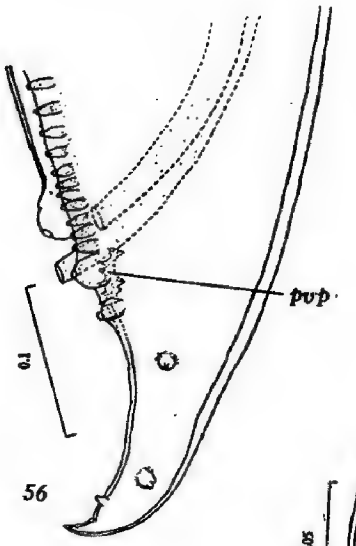

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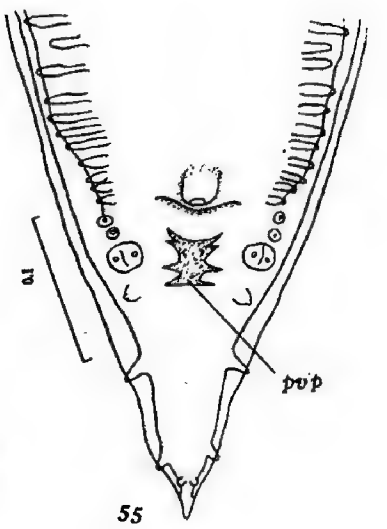

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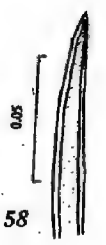

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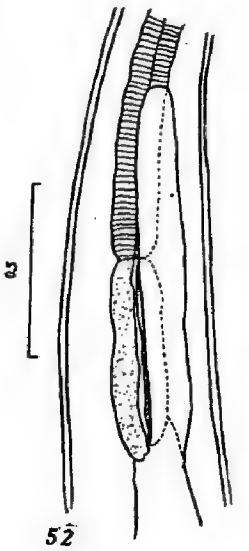

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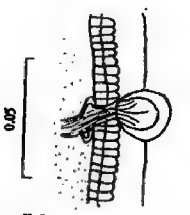

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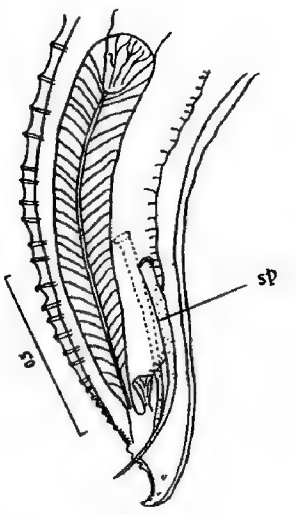

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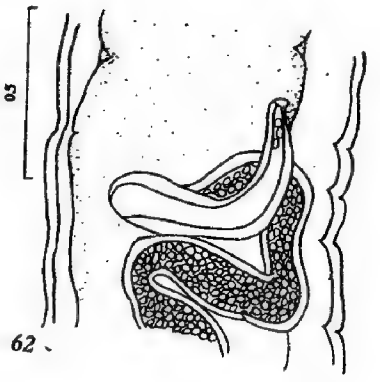

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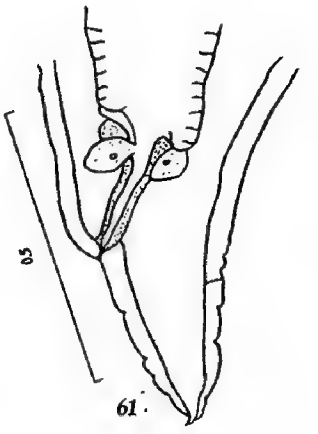

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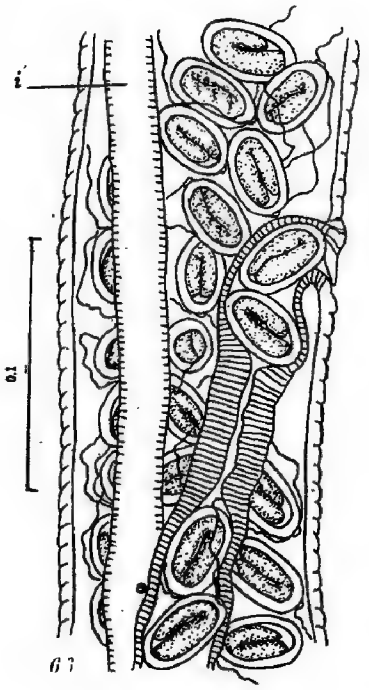

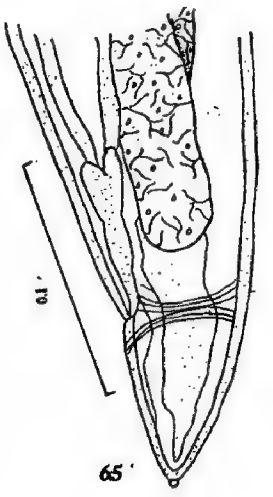

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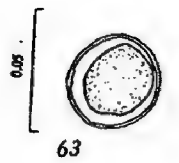

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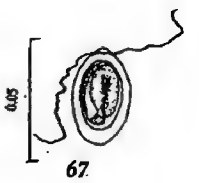

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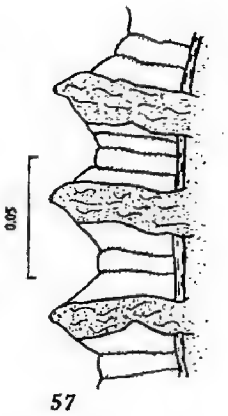

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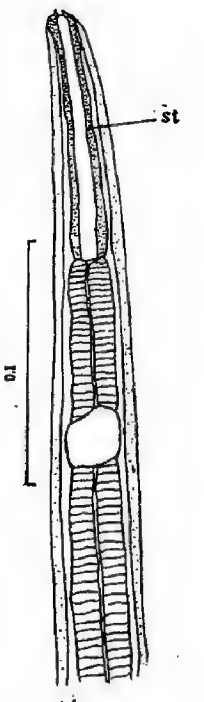

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PLATE V

Cucullanus hansoni

Host: *Balistes capistratus* Shaw

Locality: Hawaii

Fig. 68. Anterior end, left lateral view.
Fig. 69. Posterior end of male, lateral view.
Fig. 70. Posterior end of male, lateral view, under higher magnification.
Fig. 71. Posterior end of female, lateral view.
Fig. 72. Egg.

Cucullanus longipapillatus

Hosts: *Melichthys buniva* (Lacépède)—type host; *Balistes vidua* Richardson

Locality: Hawaii

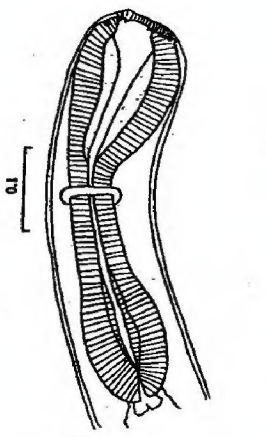
Fig. 73. Anterior end, lateral view.
Fig. 74. Anterior end, lateral view, showing entire esophagus.
Fig. 75. Anterior end, *en face* view.
Fig. 76. Posterior end of male, lateral view.
Fig. 77. Posterior end of female, lateral view.
Fig. 78. Egg.

Spirocamallanus monotaxis

Host: *Monotaxis grandoculis* (Forskal)

Locality: Hawaii

Fig. 79. Anterior end, lateral view.
Fig. 80. Anterior end, lateral view, showing muscular and glandular portions of esophagus.
Fig. 81. Posterior end of male, lateral view.
Fig. 82. Posterior end of male, ventral view.
Fig. 83. Posterior end of female, lateral view.
Fig. 84. Region of vulva of female.



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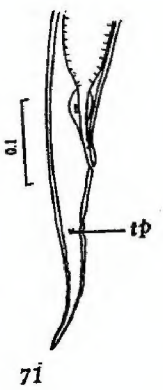

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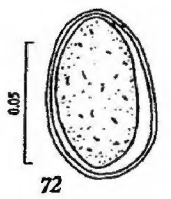

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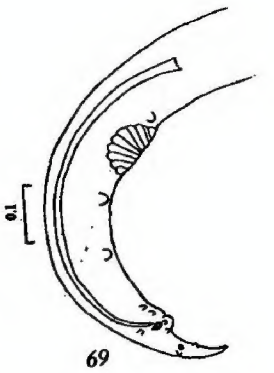

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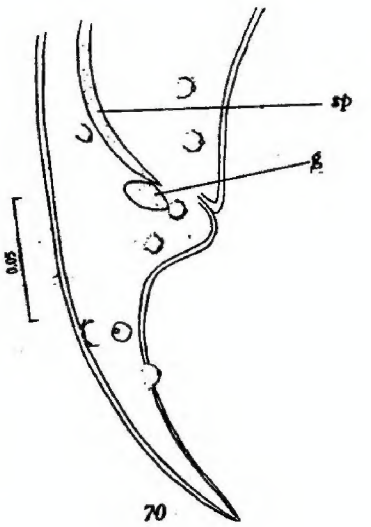

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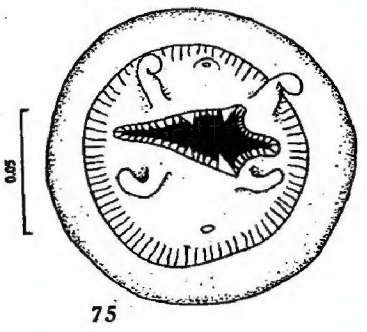

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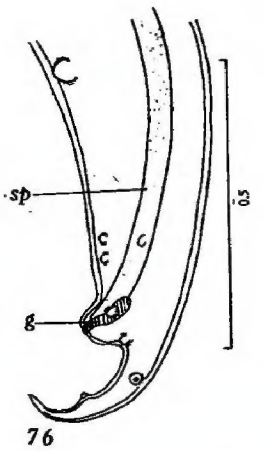

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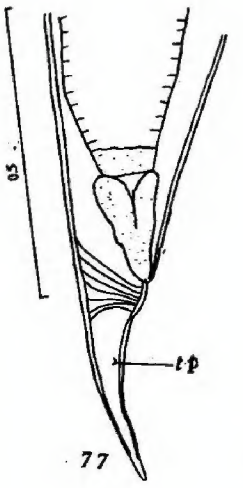

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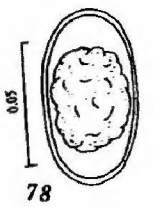

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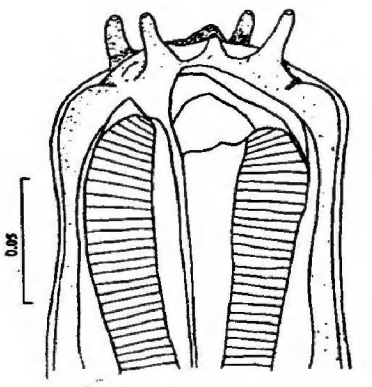

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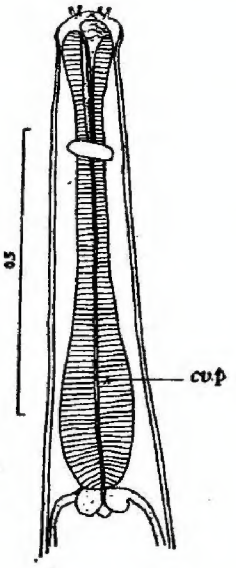

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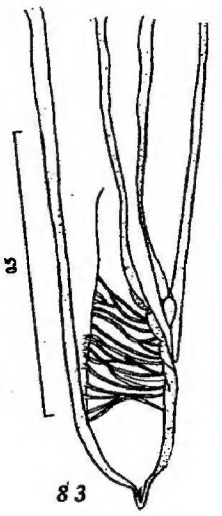

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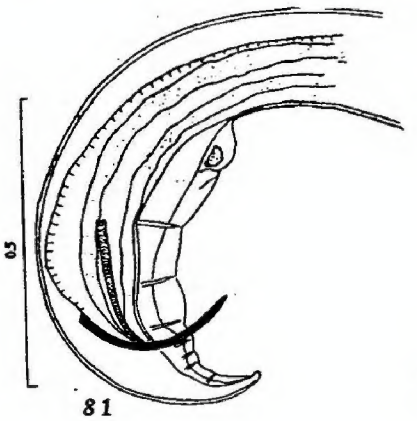

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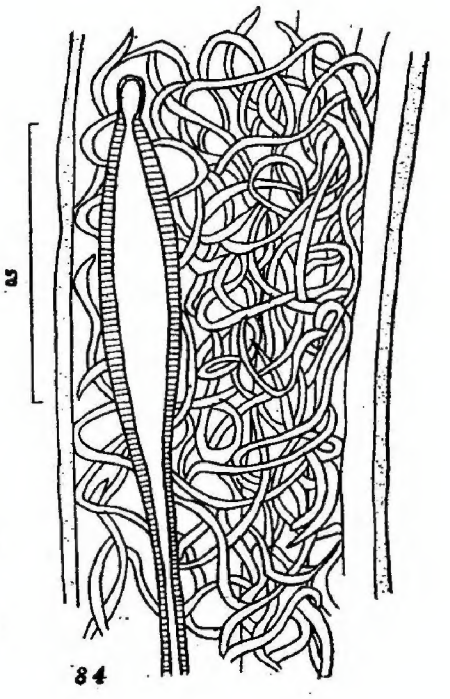

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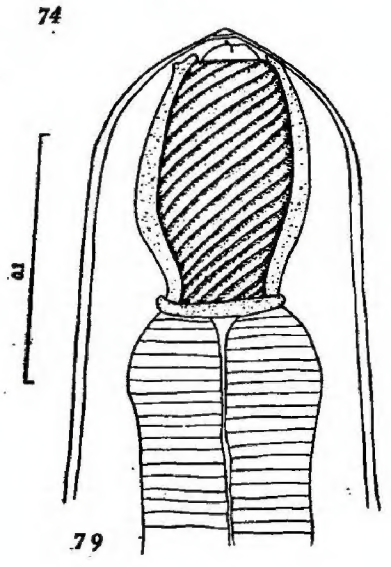

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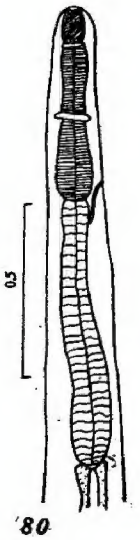

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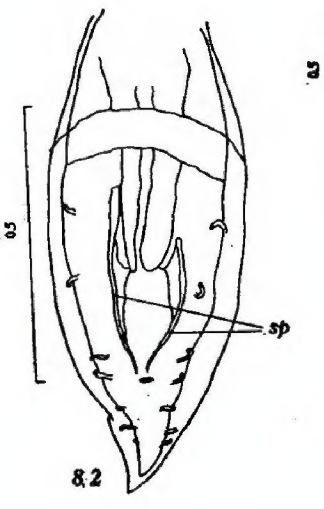

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